ELECTRICAL REVIEW

and WESTERN ELECTRICIAN with which is consolidated ELECTROCRAFT

VOL. LXIII, No. 25. CHICAGO, SATURDAY, DECEMBER 20, 1913. ISSUED WEEKLY.

COMPRISING

ELECTRICAL REVIEW WESTERN ELECTRICIAN ELECTROCRAFT

ELECTRICAL REVIEW PUBLISHING COMPANY
608 SOUTH DEARBORN STREET
CHICAGO

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ELECTRICAL REVIEW AND WESTERN ELECTRICIAN

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SUBSCRIPTIONS.

One Year, United States.....$3.00
One Year, Canada..... 4.00
One Year, Foreign Countries..... 6.00
Single Copy, 10 cents. Back numbers, beyond one month, each .25

Entered as second-class matter, November 7, 1908, at the Post Office at Chicago, Ill., under the Act of March 3, 1879.

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JOIN THE SOCIETY FOR ELECTRICAL DEVELOPMENT.

At the recent meeting in Philadelphia of the National Commercial Gas Association, a great deal of enthusiasm was aroused among those present by the announcement of plans which contemplate the raising of a fund of $300,000 to carry on an active campaign of publicity and education to increase the use of gas for lighting the home, the factory, the street, and for heating and cooking. Anyone who thinks that the strides which have been made by the electrical interests in the last 10 years have gas completely on the run should have been in attendance at this session to receive a very substantial and awakening jolt. In answer to improvements in incandescent and arc lighting by electrical means, the Welsbach burner has been improved and adapted to every condition of artificial lighting. To those who have gas installed and find it hard to make the necessary expenditure to introduce electricity into the home and the factory, there is available a mighty fine line of gas appliances and the more notice that we in the electrical industry take of this condition and realize its appeal to the householder and the business manager, the better equipped will we be to make the fight for electricity.

Gas properly advertised and with natural and artificial conditions considerably in its favor, will continue to prove a stiff competitor for electrical service. With the gas interests of the country enthusiastically behind a big enthusiastic campaign the electric light men are, as one writer tersely puts it, "going to have the fight of their lives." We do not say this out of any fear of the ultimate outcome. We have an abiding faith that because of its economy, safety, hygienic superiority and all around desirability, that electrical energy as a primary source of illumination will make increasing conquests and that finally the light of the world will be—electricity.

Similarly to our own Society for Electrical Development, the enterprising gas men of the country recognize the great value of co-operation in harmonizing the efforts of energy producer, appliance manufacturer and distributer, and that element of the industry devoted to the installation of this material. It is a good sign, this recognition of the economic principles involved, and with the electrical industry and the gas people fighting side by side—to serve

their own ends, of course—much progress must soon be made. The electrical industry must meet the emergency—must put on more steam. Only a few of the larger manufacturers can gather about them organizations capable of reaching out and touching the ultimate consumer. Only a comparatively small number of big central stations can gather about them organizations that will reach out and touch the consumer in their own districts, establish a wise control over the diversity, and improve the load-factor so that reductions in rates and adequate service can make the use of electricity universal. There are now and probably always will be a great many manufacturers and central-station companies who cannot maintain the campaigns of publicity and education that will bring about the rapid development of the electrical industry that is necessary for the greatest success.

In this contingency it seems as though the Society for Electrical Development, Incorporated, was developed just at the psychological moment, when everyone interested in the growth of the industry might wisely take advantage of the opportunity it offers. The Society for Electrical Development is the answer to the demand for a vehicle or medium by which a great many of us may subscribe a small increment of our earnings into a grand effort to reach out and touch all the people and reflect back a demand upon all the elements devoted to the electrical industry.

To the central-station man particularly the opportunity appears to be especially beneficent. So desirable has this possibility of practical co-operation appeared that there remains only a small amount necessary to complete the original fund of $200,000 which the Society for Electrical Development has in contemplation for the beginning of its educational campaign. It is now the proper time for those who have been tardy in affiliating with the Society to get in touch and lend their strength and resources to the movement. When under way it cannot be doubted but that the results will justify a continuation of the work. In the interest of a greater industry in the very near future let us "all together, all the time, for everything electrical" decide now, before the close of the year, to join with the Society for Electrical Development and usher in as speedily as possible that day of universal electrification so greatly to be desired.

In other pages of this issue there are published certain details of the recent meeting of the National Commercial Gas Association and the plans of this organization with respect to a campaign of education referred to in the foregoing. There are also some interesting communications from prominent men in the electrical industry and the financial world relating to the Society for Electrical Development. These matters are respectfully offered for the careful consideration of all those having the advancement of the electrical industry at heart.

THE FORWARD MOVEMENT.

In the November 26 issue of our esteemed contemporary *Electrical Industries*, of London, England, an editorial entitled "The Forward Movement" discusses the desirability of an organization among electrical men in Great Britain similar to our own Jovian Order. They have a pretty good idea abroad of what the Jovian Order means. To quote their own language: "They lose no opportunity of advocating the various uses of electricity in the home, the shop and the factory. They are automatic boosters of electricity on tap. Individually and collectively they provide a strong force which seems to give material aid to the various agencies of publicity in stimulating the progress of electricity."

In commenting on the possibility of establishing a similar organization in Great Britain, it is interesting to note a further recognition of the exhibition of a peculiar degree of temperament as opposed to the staid and solid conduct of the man abroad in his association work. We therefore quote our contemporary as follows:

"The most obvious comment is that in America there is a primary tendency to enthusiastic assumption, to flag-waving, badge-wearing, the shouting of war-cries, and the holding of lively conventions. Americans move freely in a glowing atmosphere which would make an Englishman feel conspicuous and self-conscious. It is only in political work that we become vocal and demonstrative; in all other matters we would rather lose ground than imperil our dignity. Every one of our engineering associations —even the most convivial—is apt to become invaded sooner or later by the creeping paralysis of propriety. There is little to be gained by grumbling and protesting against this feature of our professional life; it is congenital and ineradicable. On the other hand, it is equally necessary to recognize that there is at present, in the electrical industry, a considerable element of discontent. It is not discontent with low rates of pay and low rates of promotion; such discontent is of all time. It is a feeling that the industry lacks any machinery for giving a sustained forward impulse. Naturally enough, this discontent is most lively among the younger men. We have it voiced most uncompromisingly by men who are beginning to take responsible positions and will be at the head of affairs within another ten years. We hear echoes of it in the meetings of the Point Fives, the Batti-Wallahs, and other associations which do not meet in the Embankment Building. If by any means these restless and progressive elements could be united and their energies co-ordinated, the result would be an organized advance which would have a considerable effect within as well as without the industry."

One of the important results of the last annual meeting of the Jovian Order is the establishment of a Commercial Division. While the ultimate development of the idea is somewhat hazy, it is a step in the right direction. We have all joined the Jovian

Order not because there has been evident any immediate prospect for the development of a big idea, but because there has been evident and there is with every one of us an abiding faith that when properly organized the Jovian Order will become of primary importance and influence in the electrical industry. The last issue of *The Jovian Bulletin* should be read by every Jovian from cover to cover, and to those who are outside of the Order it is recommended that they borrow from some Jovian this issue, which contains a report of the last annual meeting, and read what Jovianism stands for and what it has accomplished to date. No one reading this report, if he is a Jovian, can help being proud of his affiliation, and no one, if he is not a Jovian, can read the report without having something stir him akin to a desire to become affiliated. In point of numbers the Order is now strongly intrenched in the industry. It remains for those who are intent upon its further development to incline their ideas towards a further unification of movement and a desire to co-operate with Jupiter and the Congress to make substantial progress in the growth of the Commercial Division idea during the coming year. If Jovians will keep in touch with Jovianism through attention to the work of their local sections, and keep informed of the progress made all over the country by a careful reading of *The Jovian Bulletin*, much of what we have long hoped for will soon be possible of accomplishment.

THE PROPERTIES OF INSULATING MATERIALS.

Of the three important materials entering into the construction of electrical machinery and apparatus the properties of one, the copper, are very well known; those of the second, the iron, are not so uniform but are tolerably well known—sufficiently so for satisfactory design; while of the properties of the third, the insulating material, comparatively little is known. Investigations of the properties of such materials have been made from time to time and considerable data have been obtained, but these are largely of a disconnected nature and no one has as yet been able to show in a comprehensive manner the principles underlying all of the behavior of this class of materials.

The subject is brought to attention this week through papers presented before the national societies of electrical engineers in this country and in England. Abstracts of these papers are given in this issue. The paper presented by Mr. F. M. Farmer before the American Institute of Electrical Engineers takes up one specific phase of the problem and experimental results are given which show that the apparent electric strength against rupture in gaseous, liquid and solid dielectrics depends, in the case of a thin layer of the material, upon the area of the electrodes used in making the breakdown test. Moreover, the strength per unit of thickness is dependent upon the thickness, or to state it differently, the total strength is not proportional to the thickness. Previous experimenters have found similar results, so that these empirical relations cannot be doubted. Whether they are spurious in the sense of being dependent upon the method of making the test remains to be shown, but the evidence at present available is against any such assumption. Tests carried on with direct instead of alternating voltage, however, would shed considerable light upon this aspect of the question.

In view of this dependance upon the shape of the insulating material and the shape of the conducting material adjacent to it, the design of this portion of electrical machinery is almost completely empirical. Under such conditions, in order to make use of test results, it is highly essential that the exact conditions of such test results shall be known and understood and to this end it is very desirable to have standard test conditions formulated and universally used in commercial tests. The American Society for Testing Materials has a committee working upon this subject and by co-operation with the Standards Committee of the American Institute of Electrical Engineers it should be possible to formulate specifications for this purpose which would be commercially satisfactory and meet present-day needs. Future research, which is so badly needed in this field, would no doubt require modifications of such specifications.

The paper presented by Mr. S. Evershed to the Institution of Electrical Engineers in Great Britain deals with another property of insulating materials, namely, the leakage resistance. The results obtained in the experiments of Mr. Evershed are very interesting, especially those which lead up to an explanation of the behavior of those insulating materials which absorb moisture. The true resistance of such materials, which must be distinguished from the apparent resistance obtained by some of the common methods of measurement, is found to vary with the voltage applied as well as with the amount of moisture which has been absorbed by the insulation. It is also well known that the mechanical pressure upon the specimen will affect this property. Mr. Evershed proposes not only a very plausible explanation for such behavior, but has simulated it in a mechanical model which not only shows the same behavior but serves to explain the fact that all of the moisture absorbed does not appear to enter equally into the mechanism of conduction; that is to say, the conductivity exhibited by the specimen is not proportional to the amount of moisture absorbed.

Both of these papers will repay study and both serve to emphasize the need of further research in order not only to widen our knowledge of the properties of such materials, but to afford data which can be co-ordinated in such a way as to disclose the natural laws underlying the phenomena.

Meeting and Banquet of American Museum of Safety.

The first annual conference of the American Museum of Safety was held last week in New York City in connection with the International Exposition of Safety and Sanitation.

Arthur Williams, of the New York Edison Company, is president of the American Museum of Safety and his able and earnest work in advancing the interests of the Museum was in evidence.

The various medals of the Museum were awarded at the banquet on Friday evening at the Waldorf. The New York Telephone Company was awarded the gold medal given by the Travelers' Insurance Company to the American employer who achieves the greatest success in protecting his employees. U. N. Bethell, the president of the New York Telephone Company, was present to receive the medal.

The Harriman medal was awarded to the Southern Pacific Railroad Company. The Scientific American medal was presented to George M. Schroeder. A duplicate of the Travelers' medal was awarded to the Allgemeine Elektricitaets Gesellschaft, of Berlin, Germany. The Seaman medal was awarded to the United States Steel Corporation and was received by its president, Thomas A. Farrell.

The Rathenau medal was awarded to the General Electric Company for the best device or process in the electrical industry for safeguarding industrial life and health. G. E. Emmons received this on behalf of the company.

Each of the medals was presented by Frederick R. Hutton, professor in the Department of Mechanical Engineering of Columbia University. John H. Finley, formerly president of the College of the City of New York and now State Commissioner of Education, acted as toastmaster.

The following were seated at the speakers' table: A. Van de Sande Bakhuyzen, Colonel Bellinger, T. A. Berryhill, George C. Boldt, Major Croxton, Thomas A. Darlington, C. R. Davis, Philip T. Dodge, Samuel O. Dunn, Thomas A. Farrell, John H. Finley, Arthur T. Hadley, Chaplain Headley, F. R. Hutton, Joseph Johnson, J. Kruttschnitt, Captain Kitts, George F. Kunz, H. E. McGowan, Colonel Mann, S. M. Milliken, John H. Patterson, Charles W. Price, Isaac N. Seligman, W. O. Sherman, C. F. Stokes, George M. Verity, Felix M. Warburg, William H. Welch and Arthur Williams.

Among other electrical men present were the following: Horace E. Andrews, T. Beran, U. N. Bethell, Charles Blizard, Nicholas F. Brady, C. C. Chesney, W. J. Clarke, H. M. Edwards, F. C. Henderschott, A. S. Hibbard, Joseph D. Israel, William Johnstone, J. W. Lieb, Jr., A. B. Lisle, E. W. Lloyd, L. B. Marks, T. C. Martin, William J. Moran, Thomas Murray, Thomas E. Murray, Walter Neumuller, Ward B. Perley, W. C. Potter, Harvey Robinson, Alonzo B. See, M. A. Singer, G. H. Stickney, H. F. Thurber, William H. Tolman, Philip Torchio, Guy E. Tripp, J. G. White and Hugh M. Wilson.

The International Exposition of Safety and Sanitation opened on December 11 in the Grand Central Palace. A private view was accorded a group of distinguished visitors on Thursday afternoon prior to its opening to the public.

Among the exhibitors were the following: Benjamin Electric Manufacturing Company, Detroit Fuse & Manufacturing Company, Edison Storage Battery Company, Electrene Company, Electric Automatic Railroad Safety Signal Company, General Electric Company, National Lamp Works of the General Electric Company, the New York Edison Company, Westinghouse Electric & Manufacturing Company.

Electrical Exports for October.

The following data relating to the electrical exports from the United States for last October are taken from the monthly summary of imports and exports issued by the Bureau of Foreign and Domestic Commerce, Washington, D. C.

October was the best electrical export month of the present fiscal year and the total value of its shipments was within $42,300 of the record total of last May. It exceeded September's total by over a quarter million dollars and October of last year by nearly half a million dollars. The number of articles exported in October for the four classes for which the numbers are reported were: electric fans, 2,197; arc lamps, 223; carbon-filament lamps, 213,016; metal-filament lamps, 76,212.

In the following table are given the classified figures for October and also for the corresponding month of a year ago, as far as the detailed figures for the latter are available.

Articles.	Oct., 1913.	Oct., 1912.
Batteries	$ 53,078	.....
Dynamos and generators	245,569	$ 244,919
Fans	26,582	34,011
Insulated wire and cables	304,561	.....
Interior wiring supplies, etc. (including fixtures)	86,039	.....
Lamps—		
Arc	2,988	16,464
Carbon-filament	23,715	11,732
Metal-filament	16,918	56,499
Motors	411,784	287,074
Static transformers	150,838	.....
Telegraph instruments (including wireless apparatus)	3,910	31,589
Telephones	190,875	100,845
All other	999,726	1,295,368
Total	$2,516,583	$2,078,501

Government Ownership of Telegraph and Telephone Lines Under Consideration.

Government ownership of telegraph and telephone lines in this country is being seriously considered by President Wilson and Postmaster General Burleson. The subject is now being investigated by the Post Office Department and it is believed that the Postmaster General is personally in favor of government ownership. The following statement by the Postmaster General is quoted in the daily press:

"There is a widespread feeling that government ownership of telegraph and telephone lines is the logical successor of the parcel post. We are the only great nation that does not control, at least in part, these facilities. My mind is open on the subject. I have taken up the matter with President Wilson, and he also has an open mind. There will be no hasty action, but I believe that we will arrive at a conclusion on this subject that will meet with the approval of the people.

"I shall have something to say on the question in my annual report. I had a long talk with Sir Herbert Samuels, head of the British postal system, regarding government ownership of telephone and telegraph systems, when he was in Washington, some weeks ago.

"We are carrying on an investigation of government ownership of these facilities in European nations. When we begin to think of taking over for ourselves the property valued at from one hundred to three hundred millions of dollars, we see how gigantic the project is and we must make haste slowly. I desire to do the work in such a way that it will meet with the approval of those in charge of legislation on Capitol Hill. Everybody's rights must be protected."

While no definite program for the purchase of the various telegraph and telephone lines has been formulated as yet, a preliminary survey is being made, and indications point to considerable Congressional support under the leadership of Representative David J. Lewis, of Maryland.

Outdoor Substations to be Discussed at Chicago.

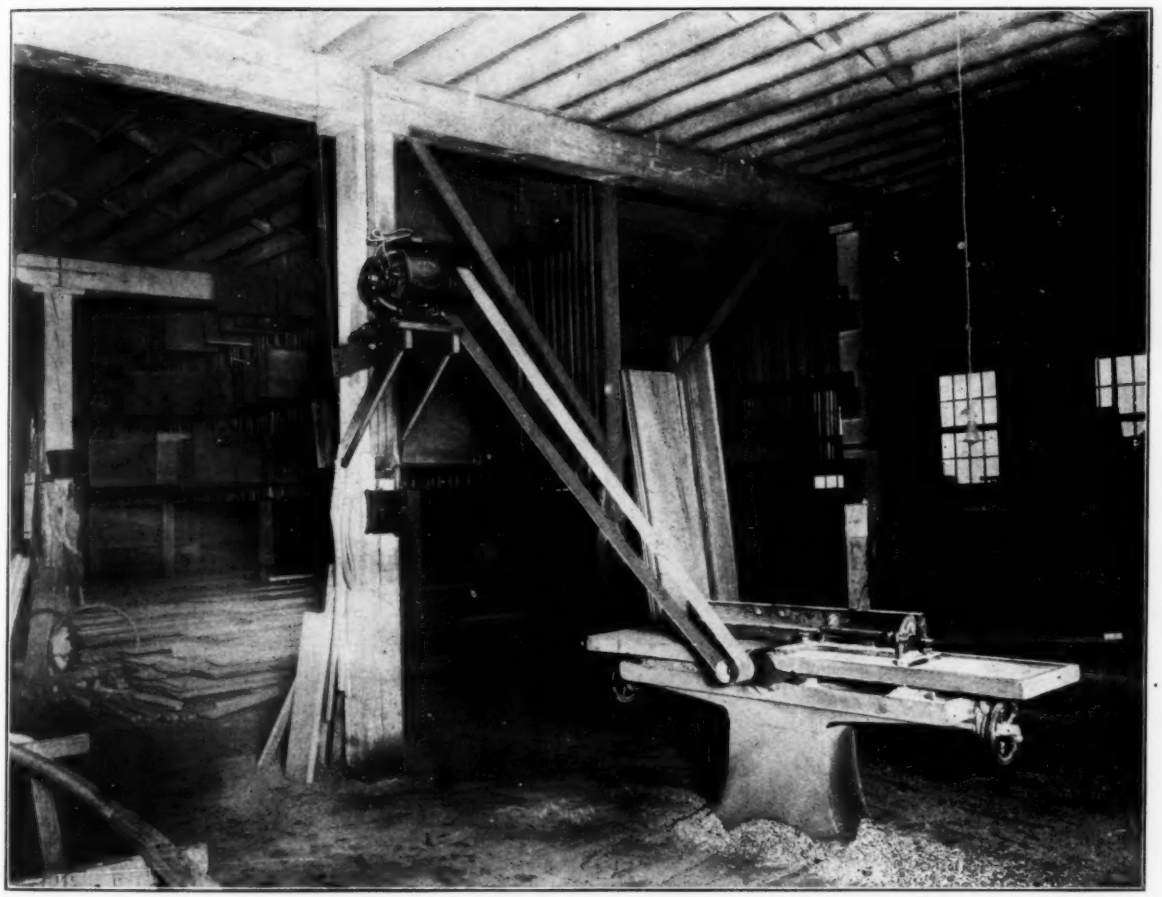
The next joint meeting of the Chicago Section of the American Institute of Electrical Engineers and the Electrical Section, Western Society of Engineers, will be held in the rooms of the latter society, Chicago, on the evening of December 29. H. W. Young, president of the Delta-Star Electric Company, will present an illustrated paper entitled "Moderate-Capacity Outdoor High-Tension Substations."

Electricity in Show-Case Manufacturing.

Show-case factories do not differ materially from other woodworking plants in which the advent of central-station service has effected such marked economies. This article discusses the general advantages of motor drive; the types of motors best suited for the machines at hand and gives typical comparative cost data.

Show-case factories do not differ materially from other woodworking plants insofar as the purchase of power is concerned. It has been proven conclusively that although wood refuse in varying quantities is available for fuel, comparatively few plants have so much waste that they can generate power at a cost that will not admit of central-station competition. The ability of central stations to furnish energy to show-case factories at an attractive figure, however, depends to a large extent upon the proper utilization of the refuse.

In many communities a ready market can be found for kindling, shavings and sawdust and it has been found that in many instances the revenues from such sales go far in paying for the cost of current. By judiciously conserving the refuse that is unsalable, enough fuel is generally available to furnish all steam necessary for dry kilns and heating. In one plant the sole object of the fireman was to burn refuse with the greatest dispatch possible and coal had to be purchased during the entire heating season. When central-station power was purchased this fireman was instructed to consume all refuse finding its way to the boiler room. In the summer months this was stored and saved for use during the heating season. Central-station service was thereby enabled to effect a marked saving in operating costs as practically no coal had to be purchased.



Two-Horsepower Shunt-Wound Motor Driving Jointer.

One of the important arguments to be remembered by the power solicitor is the marked reduction in fire risk where central-station power is used. If power is obtained from an adjacent steam plant the fire risk is great and insurance rates correspondingly high. Mechanical drive necessitates either the dangerous proximity of the boiler room or heavy losses in long steam mains or rope transmission. If central-station power is used, all danger from adjoining power plant is removed; also, the elimination of heavy line shafts greatly reduces the danger of fire from overheated journal boxes or from spontaneous combustion of accumulated oily waste or shavings. It should be remembered that the rate charged by the insurance companies, especially where steam boilers are in close proximity to the working machines, is exceedingly high, and that by installing complete electrical equipment in a modern fireproof building the annual premiums may be reduced from perhaps 7 or 8 per cent to three-quarters of one per cent. In many cases the savings in premiums will

go far in making up for the original cost of the electric installation.

Other points to be borne in mind by the solicitor are: electric drive permits uninterrupted operation of tools and the attainment of high shop "time-factor"; improves quality of product, as good product from woodworking machinery is largely dependent upon a drive capable of transmitting even and constant torque to the cutting tool; economizes unit cost of product, either by increasing product with a given equipment and personnel, or by direct economies in those charges debited exclusively to power; eliminates shafting and belting, allowing better placing of driven machines and reducing to a minimum the dissemination of sawdust and flying particles; permits the maximum return from those machines whose productive capacity is largely dependent upon the proper maintenance of speed and power, etc.

It practically eliminates overhead shafting and belts which not only disseminate dust and interfere with the proper distribution of light and air, but frequently limit the location or re-location of machinery and thus prevent that uninterrupted sequence of operations which is essential in order to avoid the rehandling of work with its attendant expense, damage and congestion.

It effects a reduction in the amount of floor space required and combines an improvement in the general appearance of a plant, with cleanliness and safety.

An important feature of individual motor drive is the ability to operate any group of machines or any separate machine overtime or at unusual hours without putting the whole plant into operation. This feature is of especial importance when the current is obtained from an outside source as in that case the cost of running any machine stops when the machine does.

The majority of the woodworking machines are operated intermittently; the tools being run at high speed complete the cut quickly and an off-load period occurs between the completion of one cut and the beginning of another. This permits the rating of the motors on a very favorable basis as they will withstand temporary overloading without injury. When designing a woodworking plant it should be borne in mind that electric drive will permit of additions being made to the original plant without interfering with the apparatus already installed.

Inasmuch as motor drive does not require the heavy shafting and belting inseparable from mechanical drive, the building itself may be of lighter construction, as the motors may be installed on the floor, wall or ceiling and connected to the machines by short belts, or they may be directly coupled to the driving shaft of the machine.

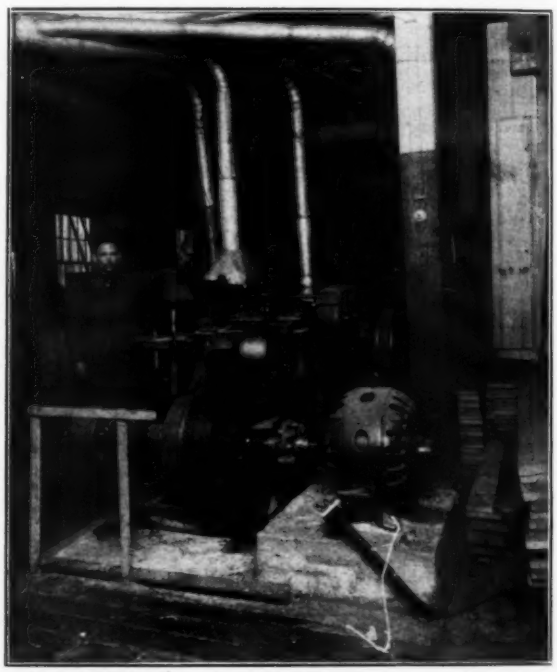
The saving in the cost of building the average mill rendered possible by the adoption of motor drive will ordinarily, due to the lighter construction required, amount to about 5 per cent of the total cost of construction. In an old building motor drive will permit the re-location of the machinery to facilitate and increase production and in addition will usually effect economy in the floor space required, as well as insuring better lighting conditions.

The application of the individual electric motor to drum sanders shows a number of the points of improvement mentioned above. The rolls of a drum sander are heavy and require considerable pull to get them started and running at full speed. In a small plant, using lineshaft and steam-engine drive, it is very common to see the complete equipment slow down materially when the sander belt is shifted to start the sander, and in many cases it is a full minute before the speed comes back to normal.

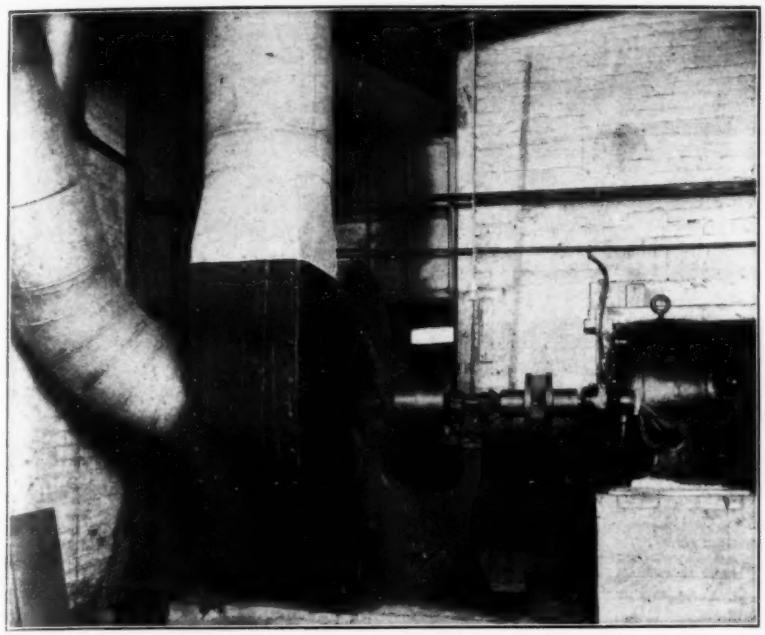
There is, of course, a slight decrease in the amount of work done at this time, due to the lower speed, but there is a more serious loss, namely, the poor work which is turned out by the machines with the slower speed. In many machines a large drop in speed causes tool marks in the work, causing it to be run over again, scraped or sanded, or in some cases discarded. This belt slippage and change of speed cannot be eliminated, and only becomes less objectionable as the size of the plant is increased, so that the power required by the sander represents a smaller proportion of the total.

When the sander is driven by an individual electric motor, with power supplied from a central-station circuit,

Fifteen-Horsepower Motor Driving Two Line Shafts.



Fifteen-Horsepower Motor Direct-Connected to Ten-Inch Molder.



25-Horsepower Motor Driving 50-Inch Blower.

as is the most satisfactory and economical method in all small and many large installations, there is no such drop in speed in the other machines, and the consequent saving is thus a point of economy for the electric drive.

The actual power required to sand a plane surface is very small, but to remove only a small fraction of an inch of harwood may take several horsepower. It often happens in made-up and glued stock that there are irregularities which must be taken down, and this means a heavy load on the motor. Consequently, when running there will be wide variations in the power requirements, varying from the friction load of the machine to a considerable overload on the motor. With line-shaft drive a varying load means varying belt slip, which traced back to the prime mover, amounts to many per cent, causing speed fluctuations all along the line, and likewise affecting the production of the machines.

Individual motor drive gives a practically uniform speed over a wide range in load, and any slight variation that may occur does not affect any other machine. With the belted motor drive as above outlined, the friction load of the machine, which includes that of the countershaft, is often a very large percentage of the total power required when working on average stock. It may, for instance, constitute from 50 to 75 per cent of the load, and this high value is due in a large part to the bearing friction caused by the four tight belts, not considering the feed belt.

20-Horsepower Motor Direct-Connected to 30-Inch Double Planer.

To overcome this waste of power, a geared drive, with a motor for each roll and one for the feed, has been designed and has proven quite satisfactory. The saving in power, based on practically continuous operation, would amount to more than $5 per month, and, besides this, the item of belt maintenance is entirely eliminated. No auto-starters are required for motors of this size, and the knife switches used for connecting the motor to the line are inclosed in metal boxes mounted on the wall and post. Metal conduit is used for the motor wiring, which practically eliminates all fire risk from that source.

With an individual gear drive as above outlined there is a definite and positive speed for each drum, while with belt drive there is the ever-present belt slip. There is no method, when belting from a countershaft, to maintain the same tension in all three of the belts, consequently there is a different amount of slip in each belt. The slip increases rapidly with increasing load, so that it may happen that the drum which should be doing the most work is doing hardly any. This shifting of the load reduces the capacity of the machine, also increases the wear on the sandpaper, since the work is not done by the proper paper.

Selection of Motors.

The selection of the proper motors for driving woodworking machines used in show-case factories is of the utmost importance and should be given the proper consideration by power engineers. If only direct-current supply is available, motors should be compound wound or of the interpole variety, since it is absolutely essential that the motors be capable of resisting the inherently excessive peaks which are apt to occur during the all-day load of the great proportion of woodworking machinery. Direct-current motors should be totally inclosed, except in those special cases where the driving machines are ceiling-suspended away from shavings and sawdust or located in a separately partitioned room, in such a manner as to eliminate all fire risk.

Large motors should be artificially ventilated and supplied with piping to and from outlet openings (1.5 cubic

feet of air per minute per horsepower is usually sufficient). All controlling appliances of whatever nature, if exposed to sawdust and shavings should be totally inclosed.

Where alternating-current supply is available, the polyphase induction motor with high-resistance squirrel-cage rotor should be specified, since the high-resistance rotor permits quick and frequent acceleration and provides the heavy starting torque required to overcome the inherently great inertia of woodworking machines. The type of alternating-current polyphase motors with polar-wound rotor and internal starting resistance, while possessing admirable torque and starting current characteristics, is not generally recommended for woodworking machines since sawdust almost invariably may be expected to collect on the starting resistance. In a few cases where variable speed with electrical control is desired, polar-wound internal-resistance rotors with collector rings and external resistances may be used. However, specifications should call for inclosed collector rings in installations of this kind.

Comparative Costs.

No better illustration can be given of the advantages of electric drive than in cases where it forces competing motive powers out of business in the face of unusually low fuel costs. In this connection the following particulars are given of the successful introduction of electric drive in a representative showcase factory, the adoption of electricity having been effected on the basis of a lower operating cost per year than the original steam plant, even when refuse sawdust and shavings were burned under the boilers.

The local central-station organization in this particular case pointed out that the ideal arrangement for the use of electric energy is a separate motor for each machine, but suggested that when the energy saving by this method ceases to pay 15 per cent on the investment it is not a success from a strictly financial point of view, although the cleanliness, convenience and flexibility of such an installation sometimes make it more desirable. The conditions in this plant, however, did not seem to warrant a complete installation of individual motor drive.

An analysis of the conditions prevailing under steam operation were found to be as follows:

	Horsepower.
Maximum load on day of test	20
Average total load on day of test	8.8
Friction load on day of test	5.5
Average total productive load on day of test	3.3

The average total productive load if the machines had been fully loaded during the entire time on the test, not including the 5.5 horsepower of friction would have been 7.96 horsepower. This figure was used in the cost estimates which drove the steam engine from the plant, rather than the actual average productive load. From the records of the manufacturing company the following yearly costs of steam power were reduced for two successive years; first year, $1,176; second year, $1,366, giving an average of $1,271, or $106 per month. The principal items were coal, averaging $600 per year, and engineer's wages, average, $526 per year, other small items being oil, waste, packing, engine repairs and miscellaneous. None of these small items much exceeded $40 per year individually.

The motors in this plant were arranged as follows:

	Horsepower	R. P. M.
First Floor—Individual Drive—		
Rip saw	5	1700
Planer	10	1700
Sticker, 12-inch	10	1700
Swing saw	3	1700
Second Floor—Individual Drive—		
Planer	7.5	1700
Sticker, 6-inch	5	1700
Rip saw	5	1700
Joiner	3	1700
Dado saw	3	1700
Band saw	3	1120
Group Drive—		
Tenoner, mortiser	5	1700
Sander, emery wheel, grindstone	5	1700

All motors are three-phase, 60 cycle, induction machines.

The average load used in the estimated cost of electric service was based on the supposition that all machines not used during the day of test were operated at their maximum capacity for the entire time that the machines were in service, as the machines were only operating under a maximum load for approximately 50 per cent of the time that they were in operation. A large amount of saving was apparent in the estimated cost of electrical service.

The average load (7.96 horsepower) eight hours per day and 26 days per month took 1,240 kilowatt-hours monthly; at 4.6 cents per kilowatt-hour energy cost was $57.10 per month, to which was added oil at $1.50, so that the total yearly cost of electrical operation was $703, compared with $1,271 for steam. The estimated saving by the use of electricity was, therefore, $568 per year, and this led to the installation of the motor drive as indicated above.

The old steam plant was given additional advantages in determining the relative yearly cost of operation, and still electricity was shown to be preferable. Thus the electrical costs were figured upon a total operation of 312 days per year against an actual service by the old steam plant of 256 days. The average number of workman-hours with steam drive was 24.5 per day while with electricity this came to 36. The estimated cost of motors was $1,219 installed, the cost of placing the motors at the mill door being $1,080, material to be used in the installation work, $108, and the labor of wiring, $31.

The installation of electric drive resulted in the elimination of the main shaft and three auxiliary lines of shafting besides cutting out 15 belts of varying length and sizes. The results of the first year's operation were as follows:

Total cost of energy	$419
Maximum bill for any month	$ 55
Maximum kilowatt-hours for any month	920
Minimum kilowatt-hours for any month	220
Maximum demand	16.5 horsepower

In another plant, located near Chicago, the following conditions were found to obtain under existing steam operation:

	Yearly.
Service of engineer	$ 900
Fuel	1,280
Water	40
Oil, waste, etc.	60
Repairs to engine	100
Repairs to boiler	150
Total	$2,530

After thorough test of steam drive in this plant it was found that an installation of 130 horsepower in 10 motors would be ample. From operating test figures it was found that the average running load would be 40 horsepower, maximum. As the plant operated 9 hours per day, 26 days per month, the estimated consumption was 7,020 kilowatt-hours per month. At a rate of three cents the monthly bill therefore was $210.60 or $2,527.20 per year. This compared with steam operating costs show only a slight saving. However, the installation was made and the refuse which was previously burned is now sold and actually pays 60 per cent of the power bill. A considerable net saving was therefore effected by the change.

Safety First.

In an advertisement advocating the use of electric lamps for the illumination of Christmas trees, the Union Electric Light & Power Company, of St. Louis, reproduces a letter from the chief inspector of the St. Louis Fire Prevention Bureau which comprises a statement ragarding the large number of fires occurring through the use of candles for illuminating Christmas trees. The fire hazard of this practice is pointed out and the superiority of incandescent lamps for the purpose is emphasized. This advertisement emphasizes the principle of "safety first" in providing a Merry Christmas for the little ones.

Rates Reduced in Montana.

The Montana Power Company, which serves 33 Montana towns, has made substantial reductions in rates in all of these, the average amounting to about 33 per cent.

Commercial Practice
Management, Rates, New Business

Analysis of Power Conditions in an Electrically Operated Laundry.

Within the past year an extensive investigation of power conditions in an electrically operated laundry employing an average of 55 girls and men was made for the purpose of ascertaining the relative merits of steam and electric power; the operating characteristics of the various machines under service demands; the monthly and yearly cost of power with electric drive; the possibilities of improving the existing conditions and equipment; and the advisability of installing a turbo-generator for service in conjunction with the boiler equipment in use in the establishment. The results were embodied in a report of 128 pages, from which the following notes are drawn for the benefit of the central-station power solicitor interested in this class of service.

The work done weekly by the laundry usually includes 2,000 shirts, 4,000 pounds of rough-dry material, and other production in proportion, the volume of business done equalling about $1,200. Power is supplied by the local central station, and the average cost of direct-current electricity per month in 1912 for motor service was $49.47, the average energy consumption being 1,919 kilowatt-hours. The unit cost for the year was 2.6 cents for direct-current motor applications in the establishment. During the year the laundry also consumed an average of 458 kilowatt-hours per month in the operation of alternating-current motors, the average cost of this service being $11.80 per month, or 3.9 cents per unit. The lighting of the plant called for an average of 146 kilowatt-hours per month at a cost of $10.25, or 7 cents per kilowatt-hour. The maximum direct-current power consumption occurred in the month of May, when 2,223 kilowatt-hours were used, the minimum direct-current consumption of 1,688 kilowatt-hours occurring in August. The maximum alternating-current consumption of 535 kilowatt-hours was for April, and the minimum of 411 kilowatt-hours was in November. The maximum and minimum consumptions of energy for lighting were respectively 228 kilowatt-hours in November and 68 kilowatt-hours in August. All lighting service was billed at the seven-cent rate.

The equipment of the laundry is mainly operated by individual motors, although a small amount of group driving is in service. The details follow:

Machinery	No. of motors	Horsepower
Mangle	1	4.
Six washers and tumbler-drier, shaft 80 feet long	1	10.
Three extractors	3	1.5
Exhaust fan	1	2.
Body ironer	1	0.5
Body ironer	1	0.3
Sleeve ironer	1	0.3
Collar and cuff ironer	1	1.
Collar table (wing dampener, seam dampener, shaper, molder, shaper, edger).	1	1.
Bosom press	1	0.25
Sewing table	1	0.16
Blower	1	1.
Collar and cuff dampener	1	0.25
Elevator	1	4.
Handkerchief mangle	1	0.125
Two dry rooms	1	1.
Starch extractor	1	1.
Collar and cuff starcher	1	0.25
Marker	1	0.125

The steam equipment of the laundry consists of an 80-horsepower Ames boiler with a forced-draft blower connected with an automatic damper regulator. Feed water is supplied by an injector and the boiler pressure is 80 pounds per square inch. Steam is used only for heating service and the attendance is handled by one man in the wash room.

Tests of Various Laundry Machines.

A large number of tests were made of the power consumption of the different machines in the laundry, and the more important results are given below.

Load.	Motor Input, Kilowatts.
Shafting only	3.34
Shafting and tumbler dry room	4.21
Shafting and tumbler, dry room and one washer	4.77
Shafting and one wash wheel	3.89
Shafting and two wash wheels	4.33
Shafting and three wash wheels	5.42
Shafting and four wash wheels	5.93
Shafting and five wash wheels	6.38
Shafting and six wash wheels	7.44

The 10-horsepower motor operating the above equipment runs 52 hours per week. The tumbler-drier is in use 8.5 hours daily except Saturdays, when it is run three hours, or 45.5 hours total. The wash wheels are run seven hours daily and two hours Saturdays, or 37 hours weekly. All are driven from pulleys keyed to the line shaft mentioned in the table, the blower being treated as a part of the shafting load since it is in constant operation. The wash wheels and tumbler-drier reverse automatically by means of double pulleys and crossed belts. The combined capacities of the wash wheels are 825 shirts, and the summarized power consumption of this equipment is given above.

The extractors are individually driven by a 1.5-horsepower Watson motor running 1,350 revolutions per minute, and are operated seven hours daily and two hours Saturdays, or 37 hours per week. The motors are located on the floor about two feet away from the extractors, the belt drive being used. The baskets are 26 inches in diameter and about 45 seconds are required to bring the extractors up to speed. At full load and under usual running conditions the power input to the extractors was found to be 0.97 horsepower for No. 1; 0.91 horsepower for No. 2, and 0.85 horsepower for No. 3. Nearly eight times as much power is required to start the extractor as is needed to operate it after reaching full speed. The maximum values of power taken at starting were: extractor No. 1, 9.95 horsepower; No. 2, 5.88 horsepower; and No. 3, 6.21 horsepower. These differences in the power input to the different extractors at the start were attributed to varied loads. It is not practicable to load the machines equally at each service and the operator only approximates this. After the extractor has reached its normal speed any slight variation in load is not noticeable in the reading of power input to the motor. At starting, the motor is obliged to overcome the inertia of a large mass and the differences in power consumption are greater. The power taken at starting varies also with the speed at which the rheostat is operated.

The exhaust fan, 40 inches in diameter, is operated by a direct-connected motor, and the power required to drive it varies nearly uniformly for the different controller positions, regardless of the direction of rotation. The fan runs on the same schedule as the extractors. The variation in energy consumption is from 0.90 horsepower to 1.67 horsepower between the first and eighth controller speeds, respectively.

The mangle is operated 46.5 hours per week, or 7.5 hours Mondays, three hours Saturdays and nine hours the balance of the time. The motor is geared to the rollers and the speed is varied by a hand controller, which inserts resistance in either the armature or field of the motor, dependent upon

whether a speed less or greater than normal is desired. The motor speed varies from 600 to 1,000 revolutions per minute, the normal speed being 800 revolutions per minute. The controller is of the type much used on printing presses. This method of controlling speed variations enables a smaller motor to be employed than would be the case if speed control was obtained simply from the variations in field excitation. The average power demand of the mangle under normal conditions of operation was 0.9 kilowatt on small pieces and 0.64 kilowatt on sheets.

The sleeve ironer is operated 44 hours per week, the service being required nine hours daily, except on Mondays and Saturdays, when four hours' use suffices. The motor, a 0.3-horsepower machine running 680 revolutions per minute, is belted to the ironer and the direction of rotation of the rollers is changed by gears. At no load the power input is 0.34 horsepower and at full load, 0.36 horsepower. The difference is due to the fact that at full load the sleeve is between the rollers and that one roller is pressing against the other. The power needed at the time of reversal is 0.4 horsepower. The number of reversals per minute varies greatly according to the speed of the operator.

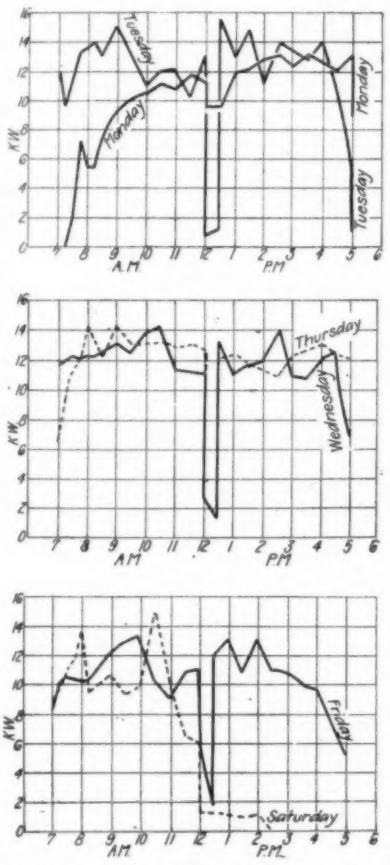
The body ironer (No. 1) operates on the same schedule as the sleeve ironer. The motor, a 0.5-horsepower, General Electric outfit running at 650 revolutions per minute, is located on the side of the machine. It is designed to be thrown directly upon the line and to reverse by means of a treadle switch and without a starting resistance. The electrically reversed machine at all times uses more power than the one reversed by gears, but at the moment of reversal this difference is a maximum, or about 3.5 times the power consumption of the gear-equipped outfit. Under running conditions the power taken by body ironer No. 1 is 0.36 horsepower, while upon reversal the momentary demand is 1.47 horsepower.

Body ironer No. 2 operates on the same schedule as the foregoing ironer, but the roller is reversed mechanically by means of gears. This arrangement allows the motor to be run in one direction at all times, the operator reversing at will through a foot lever. Under running conditions the power taken is 0.34 horsepower and while reversing, 0.43 horsepower.

The schedule of the bosom press was 44 hours per week, as above. The press is heated by steam. When the motor starts to operate the knee of the press, it overcomes a substantial amount of inertia, the power required being 0.97 horsepower. After this inertia has been overcome, the power required is 0.3 horsepower.

The motor and mangle of the handkerchief machine are located on a table and the power is transmitted to the mangle through gears. The motor is allowed to reach full speed before the load is applied. The power taken by the motor when handkerchiefs are being ironed is practically the same as when the rollers are not under pressure, and is about 0.18 horsepower.

The number of machines driven on the sewing table was two. The motor is located on the floor under the table and the power is transmitted through



Load Curves for Different Days of the Week.

a belt to a line of shafting. The motor is equipped with a friction clutch and its power input at full load is about 0.17 horsepower. The motor is never operated unless the sewing machines are in use. The sewing table is in service 15 hours per week.

The collar and cuff dampener was driven by 0.25-horsepower motor running 500 revolutions per minute, and in use one hour per day, or six hours per week. The test showed that at no load the power input to the machine was about 0.4 horsepower and at full load, 0.42 horsepower. It appeared that although the motor was overloaded, the short period of daily operation enabled the load safely to be carried.

The collar and cuff ironer runs 22 hours per week, the service being one hour on Mondays and Saturdays, and five hours each on the other days. The motor, rated at one horsepower, is geared to the ironer, and the power requirements were 0.77 horsepower at no load and 0.84 horsepower at full load.

The collar-table motor operates 35 hours per week, driving the equipment on the table by belting and shafting. With the belt on the loose pulley the power required is 0.47 horsepower and at full load, 0.57 horsepower. Only 0.1 horsepower is used by the machines on the table.

The collar and cuff starcher, operated by a 0.25-horsepower motor making 500 revolutions per minute, runs five hours Mondays and nine hours the balance of the week except Saturday, the total being 41 hours per week. The power input to the machine is fairly constant, regardless of whether goods are being run through the machine or not and averages 0.2 horsepower.

A one-horsepower motor running 1,200 revolutions per minute, and operating for sixteen 20-minute runs per day, except Saturday, drives the starch extractor by belting. The motor was found to be running slightly under its rated speed. When starting the motor takes 3.47 horsepower but when in operation, 0.4 horsepower. The average time taken by the motor in accelerating is 25 seconds.

The dry-room motor, rated at one horsepower, is placed on top of a dry room, the power being transmitted to two fans and the automatic dry room by belts and four lines of shafting. The motor is run 46.5 hours weekly, its regular schedule being 7.5 hours Mondays, three hours Saturdays and nine hours other days. The average power consumption was 0.83 horsepower.

The marking machine operates 37 hours per week, the service being 10 hours Mondays and Tuesdays, two hours Saturdays and five hours other days. The motor is belted to the marker and is controlled by a snap switch. The power consumption is about 0.118 horsepower whether the machine is stamping or running idle.

The power consumption of the laundry for a typical week was as follows:

	Kilowatt-Hours. Alternating Current.	Direct Current.
Monday	91	24
Tuesday	101	26
Wednesday	109	18
Thursday	103	19
Friday	97	22
Saturday	37	18

Total direct-current power, 538 kilowatt-hours; alternating current, 127 kilowatt-hours; combined, 665 kilowatt-hours. Lighting service, February 3 to 8, 5.5 kilowatt-hours.

The actual energy consumption of the various pieces of motor-driven apparatus for one week was as shown in the accompanying table.

	Kilowatt-Hours Used.
Washers and tumbler-drier	326.9
Extractor No. 1	26.7
Body ironer No. 1	11.7
Sleeve ironer	11.8
Collar table	14.8
Sewing table	1.9
Blower	3.7
Elevator	16.2
Dry room	21.
Starch extractor	8.13
Mangle	31.3
Exhaust fan	35.2
Extractor No. 2	25.
Extractor No. 3	23.5
Body ironer No. 2	11.1
Collar and cuff ironer	13.8
Bosom press	9.7
Hand	2.
Collar and cuff dampener	1.9
Flat irons	175.
Marker	3.3
Collar and cuff starcher	6.3

The load-factor of the installation, defined as the ratio of the actual output to the full-load output for the period of service rendered, varied from 54.1 per cent to 63.7 per cent, that for the week as a whole being 56.5 per cent.

It appeared from the investigation that if the power bills of the laundry ran from $175 to $200 per month there might be a saving in the adoption of service obtained by the installation of a turbo-generator by the establishment, but where the power bills are about $75 per month, the added expense of an engineer or fireman would be greater than the total cost of power under present conditions.

In a laundry, where heat as well as mechanical power is required for the cycle of operations, it is often stated that the additional expense of operating an engine or turbine is negligible when compared with the expense of the fuel needed solely for the purpose of obtaining steam for washers, mangles, dry rooms, presses, starch cookers, etc. For this reason the engine or turbine is considered as performing the function of an efficient reducing valve between boilers and the heating system, and as generating, at practically no cost, the electric power required by the plant. It has been claimed that 0.04 cent per kilowatt-hour is all that should be charged to power in the operating expenses of a steam laundry, based upon coal of a heating value of 13,000 B.t.u. per pound as fired and to cost $1.50 per ton, with boilers of the horizontal return-tubular type operating at 50-per-cent efficiency, supplying steam at 85 pounds gauge, and assuming that the engine uses 42 pounds of steam per horsepower-hour. This would give a thermal efficiency of 6 per cent. These figures, it was contended, would not apply to the laundry investigated, as the fuel cost was much above $1.50 per ton, and they also appear not to take into account the fact that the average small laundry labors against serious losses in boiler and engine room incidental to careless firing, leaky pipes and valves, and the usual wear and tear.

The test carried on during the typical week last winter showed that operation was for the most part satisfactory. The laundry was equipped with electric drive about seven years ago and at that time the apparatus was more experimental in character than at present. The installation tested formerly suffered much from poor voltage regulation, but owing to careful handling the equipment remains in good condition. A preliminary test showed that the pressure often dropped as low as 350 to 300 volts, which causes a severe strain upon the motors. Such a voltage drop overloads the armatures, weakens the fields and decreases the torque. On small motors, such as are used in this plant, the loss due to I^2R losses in the armature and series field is always much greater than the gain caused by the weakening of the field current. The loss in efficiency in the preliminary test, due to the drop in the voltage, was especially apparent in the extractor motors, where about 30 per cent of the ampere-turns on the field is made up by a series winding. This was also the case on the mangle motor, where a speed decrease was partially obtained through armature control. The present voltage regulation on the machines is satisfactory.

Individual drive is recommended by the authors of the report for extractor operation, and it can always be applied to machinery already installed. Wash wheels appear better adapted to group operation. The economy of individual motor drive is not based so much upon electrical efficiency as on the improved quality and increased output. Better work and more of it will soon offset any equipment which is not theoretically the most efficient. Where frequent speed changes are desired the direct-current motor seems more favorable, but as many laundry machines run at constant speed, it is possible to use, if desired, alternating-current motors for a large portion of the drive. A motor-generator set for the requisite direct-current service may readily be installed.

The authors of the report point out that standard commercial polyphase motors are unsatisfactory for laundry service. In the largest ironers a 3-to-1 speed variation is desired. A wound-rotor slip-ring machine will not give over 20-per-cent reduction in speed. One prominent maker of laundry machinery evades this difficulty by providing two stator windings on their squirrel-cage motors and pole changing through a controller, obtaining on 60 cycles speeds of 1,800, 1,200, 900 and 600 revolutions per minute. Modern mangle motors are frequently of the interpole type and obtain their speed variation entirely through field control. The typical extractor motor is built with about 25-per-cent series field and is designed to give a large torque at the start, since extractors take from 8 to 10 times the load on starting that they require on high-speed operation. The load depends greatly on how fully the extractor is packed. Extractor drive offers some interesting problems to the motor designer, for it is very desirable that an extractor motor should accelerate slowly and that the inrush of starting current should be low. A representative motor for this service takes 70 seconds to accelerate, and the starting current—without any limiting resistance and without any rotor windings—is extremely low. Machines tested at the laundry attained full speed in 45 seconds, but in the most recent practice this period is increased as above outlined. Body ironers built at present are provided with interpole motors designed to be thrown directly across the line, and they reverse by a treadle switch and without any starting device.

Brooklyn Christmas Display.

The Edison Electric Illuminating Company of Brooklyn, of which Theodore I. Jones is general sales agent, arranged an electrical Christmas display at the Edison Shop, 360 Pearl Street, from December 8 to 13. The exhibition embraced all the latest conceptions in electrical goods and was open from 9 a. m. to 9 p. m. Illustrated booklets containing suggestions for Christmas gifts were distributed. A pleasing feature of the display was a Christmas tree decorated with 500 miniature lamps in the forms of fruit, flowers and animals. Electrically cooked refreshments were served and music rendered.

Electrical Gifts.

The Electric Shop, Chicago, which is maintained by the Commonwealth Edison Company, has issued a little booklet entitled "Gifts Electrical For Any and Every Occasion." It comprises 22 pages of illustrated descriptions of various current-consuming devices which are suitable for Christmas presents. The obect is to impress people with the facilities of the Electric Shop and to bring them there to make their Christmas selections, and also to secure inquiries by mail. Prices for the various devices are given, but this feature is not made prominent.

Electrical Construction

THE ELECTRICAL INSTALLATION IN A LABORATORY.

Description of Electrical Equipment of the Physical Laboratory of the University of Chicago.

Owing to the special requirements of laboratory work, especially in a laboratory devoted to electrical or physical science, the electrical equipment must be of a special character, presenting many points of dissimilarity from the ordinary factory, office building, home or other buildings ordinarily met with. For this reason a description of the electrical installation in the Ryerson Physical Laboratory of the University of Chicago presents many points of interest.

An addition to this laboratory was completed nearly a year ago and has been dedicated during the present week. Besides rooms for class work and experimental researches, the new portion of the building contains a shop for the mechanician, a generator room containing some special experimental machines, a storage-battery room, and a switchboard room containing the panels for controlling the machines and battery and distributing their current.

Alternating current is supplied by the Commonwealth Edison Company by means of single-phase three-wire leads at 220 volts. Direct current is obtained from the power plant of the University over a three-wire 220-volt line and this supply is used for the most of the requirements for lighting and power. It enters the building through the basement where the main service board is located. This board contains two panels; one for lighting and one for power. The lighting panel has a main three-pole switch and four distributing three-pole switches, one of which supplies the special red exit lights, which are always kept burning in the building. Another of these switches controls the general lighting supply for the old portion of the building; a third the lighting of the new wing of the building, while the fourth is connected to one of the switchboards on the floor above, which will be mentioned later. Nearby in the basement there is a cutout panel containing fuses, and all of the lighting circuits are connected through it.

Upon the power panel there are six two-pole distributing switches, one of which is not yet in use. Four of the switches control circuits which supply power respectively for a liquid-air machine, a refrigerating machine, a ventilating fan and the blower for the furnace room. The sixth switch controls the power supplied to the old portion of the building.

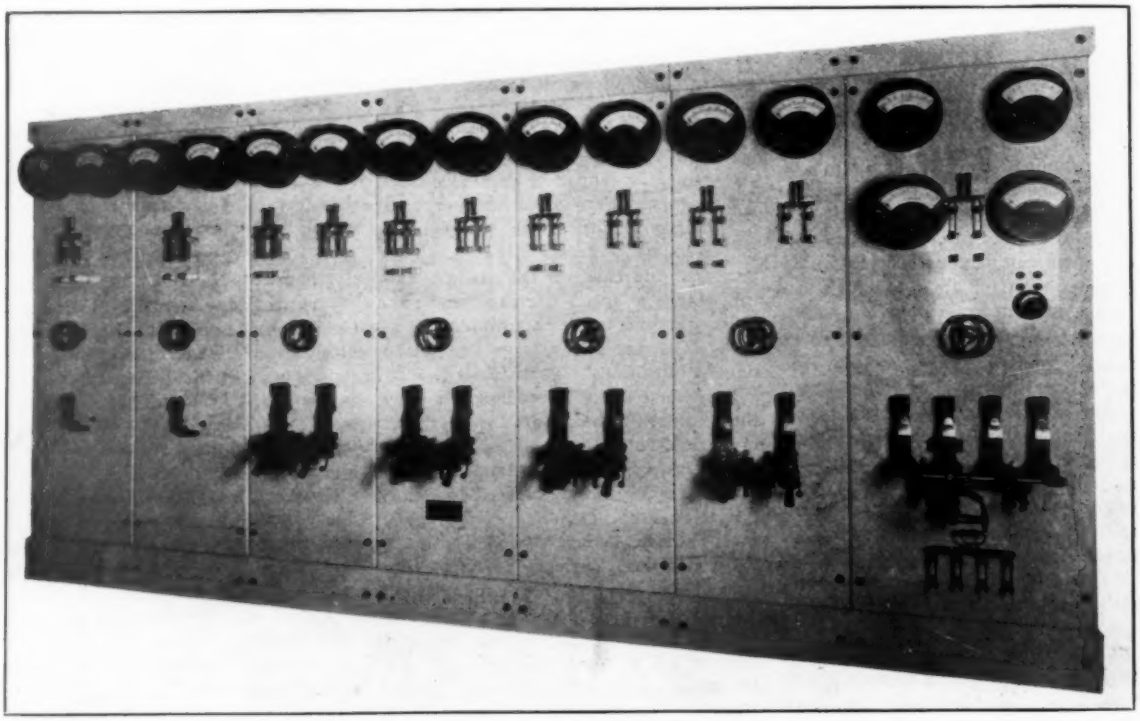


Fig. 1.—Switchboard in Generator Room.

The experimental machines which have already been referred to consist of motor-generator sets located in a room upon the main floor. These machines are controlled through the switchboard shown in Fig. 1. This switchboard contains a panel for each one of the motor-generator sets. The driving motors in these sets are all direct-current machines wound for 110 or 220 volts and range in capacity from 5 to 15 horsepower. The left switch on the upper part of each panel is in the motor circuit. These are double-throw switches. When thrown up in the position shown in

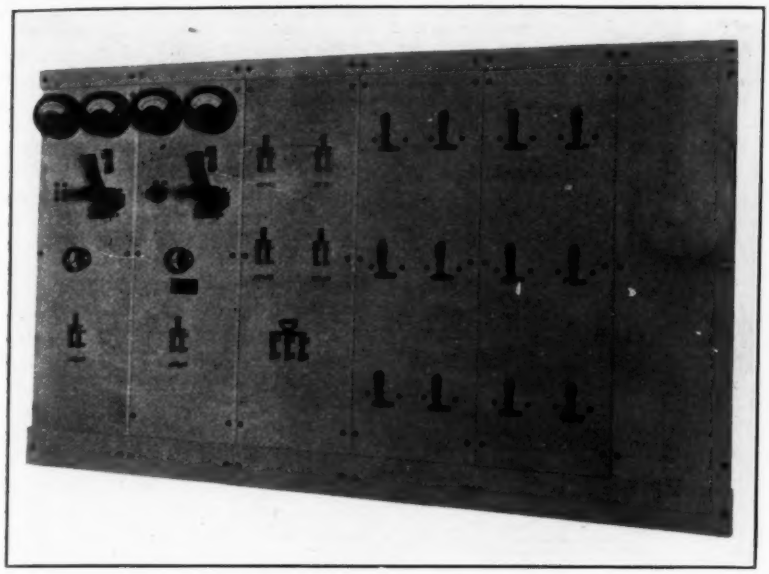


Fig. 2.—Front View of Switchboard No. 2.

the photograph the motors are connected to a circuit from the lighting panel of the main service board. When these switches are thrown down the motor is connected to a storage battery which will be referred to later. Each panel contains also a rheostat.

The first two panels at the left are for two motor-generator sets, giving 1,000 volts each and these are for direct current. The switches closing the generator circuit are oil switches mounted upon the back of the board and manually controlled by the handles shown on the lower portion of the panel. These switch handles move about a horizontal axis at right angles to the face of the panel. The connections in the oil switch are arranged as a double-throw double-pole switch, so that each generator can be connected to either of two circuits. The customary way to make such a connection is to connect the generator terminals to the middle points of the switch and to connect the outside circuits to the end points. This, however, would present the possibility of throwing both machines on the same circuit and thus short-circuiting one of them through the other. To avoid this possibility each of the outside circuits is brought to the middle points of one of the switches and the generators are connected respectively to the two sets of outside points. It is thus possible to throw two circuits on the same generator but it is not possible to throw both generators on the same circuit.

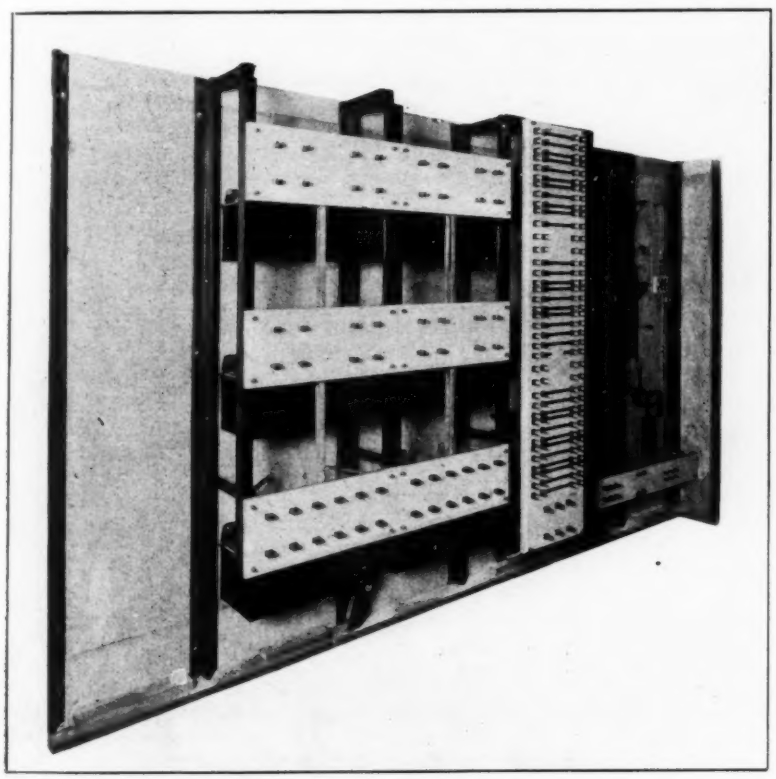


Fig. 3.—Rear View of Switchboard No. 2.

The panel at the extreme right is for the control of a motor-generator set, of which the generating end is a two-phase machine. This panel is supplied with an ammeter for each phase, a voltmeter and a polyphase wattmeter. The voltmeter may be connected in either phase by means of a set of plugs shown below it, which make the proper contact. The other panels have a voltmeter and ammeter in the generator circuit. All except the high-tension machines are supplied with Cutter I. T. E. circuit-breakers. The oil switches were supplied by the Condit Electrical Manufacturing Company.

The outside circuits from these panels run to a distributing panel in the switchboard room, which is adjacent. This room contains two switchboards for distributing current from any source to any one of the experimental rooms in the building. These two boards are designated as No. 1 and No. 2. No. 2 will be first described. The front of this board is shown in Fig. 2 and the back in Fig. 3. In Fig. 2 the left-hand panels are for charging the storage batteries. The middle panel contains distributing switches. The three-pole switch at the bottom is in the supply circuit of the Commonwealth Edison Company already referred to. The four two-pole double-throw switches enable current from the Edison circuit or from one of the four motor-generator sets already described to be thrown upon circuits leading to switchboard No. 1. The two right-hand panels control the circuits from the 1,000-volt generators and enable them to be connected to special circuits running to various parts of the building. These are supplied with oil switches similar to those already mentioned. The circuits coming to this board are run through the building in separate conduits, rubber-covered wires being used for the purpose. These circuits end in special equipment boxes, which will be referred to later.

Fig. 3 shows how fuses are mounted on marble slabs back of the board.

The Storage-Battery Connections.

Front and rear views of switchboard No. 1 are shown in Figs. 7 and 8. This board contains the most unique feature of the installation, namely, the means provided for connecting any portion of the storage battery to a circuit leading to any part of the building.

There are two main storage batteries, each consisting of 108 cells of the Edison type. One of these batteries is made up of B-4 cells having a normal discharge rate of 15 amperes. The other consists of A-6 cells having a normal discharge rate of 40 amperes. These batteries are located in a room upon the floor above. They are mounted upon wooden racks in two tiers and the wires connecting them to the switchboard are lead-covered and are run in conduit. There is also a small battery of lead cells in this room, which is used only for a special purpose and is also connected through switchboard No. 1. The battery room is supplied with a ventilating fan which drives any fumes from the charging battery out through a flue in one corner of the room.

Referring to Fig. 7, the panel on the extreme right is connected to the cells of the 15-ampere battery. This panel contains 66 vertical copper strips mounted with their edges against the face of the board. Extending across the board horizontally in front of these, but not in contact with them, are 24 rods of circular cross-section. Connection can be made from any one of the horizontal rods to any one of the vertical strips by means of contactors of the shape shown in Fig. 4. These contactors have two blades like a knife switch which fit the vertical strips. They slide along the horizontal bars and are also free to rotate upon them, except when the screw shown in the figure is tightened up. The connector is slid along the horizontal bar until opposite the vertical strip to which connection is to be made. It is then rotated until the blades engage the vertical strip and the screw is then tightened, thus fixing them in position and at the same time making firm contact with the horizontal bar. This provides a unique, safe and very convenient means of making cross connections between any one of the circuits connected to the horizontal bars and any number of storage cells connected to the vertical strips. The screw which tightens the contactor to the rod is turned by means of a handle fitting over the head of the screw and cannot easily be turned by the fingers alone. Control of the board is thus kept in the hands of the assistant in charge, who has custody of this handle.

Not all of the 108 cells of this battery are connected individually to the vertical strips, but the cells are grouped together so as to provide various voltages. These groups vary in number from 10 cells to a single cell. The terminals of these groups are brought to the vertical strips so that any voltage from that of a single cell up to that of the entire battery can be obtained by making connections to the appropriate vertical strips by means of the contactors. The battery can be sectionalized by means of the single-pole single-throw switches shown at the top of the board. There are six of these and when open they serve to insulate the different sections of the battery. They also make it possible to put five sections of the battery in parallel whenever large currents are needed. It is the intention to add 12 more cells to the battery and have six equal sections which can be paralleled.

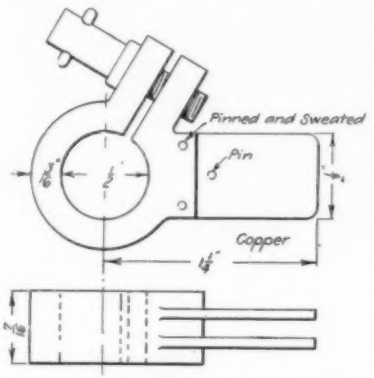


Fig. 4.—Two Views of Contactor.

Beginning at the bottom of the board the first six pairs of the horizontal rods extending across the face of the board are connected to the transfer panel, which is the third from the right in Fig. 7, through switches in the second row at the top of the panel. The next three pairs are connected to certain other rooms in the building through the three double-pole switches in the upper row. Of the remaining three pairs of horizontal rods, two are at present not connected, while the third is used for charging the battery. This pair of rods is connected directly to the middle points of the switch shown on the charging panel in Fig. 2. When this switch is thrown upward, as shown in the figure, it connects the battery to a source of 110 volts for charging. When thrown down the voltage is 220. The Cutler-Hammer iron-grid charging rheostats upon the back of the board, which had not yet been mounted when the photograph shown in Fig. 3 was taken, serve to control the charging current. The rheostat for the 15-ampere battery has a resistance of 10.5 ohms, while that for the 40-ampere battery has a resistance of 3.5 ohms. It is possible with this equipment to charge any number of cells.

The second panel from the right in Fig. 7 has the cells of the 40-ampere battery connected to its vertical strips in a manner similar to that already described for the 15-ampere battery. Two of the vertical strips, however, are connected to the terminals of the 40-ampere storage battery consisting of 20 lead cells. Similarly, six pairs of the horizontal rods are connected through switches to the transfer panel. Four pairs are connected through switches to four rooms in the building. Upon the backs of these two panels, as shown in Fig. 8, are mounted fuses, one in each line. The 15-ampere cells are protected by 20-ampere fuses and the 40-ampere cells by 50-ampere fuses. It is thus impossible to discharge the cells at very much higher than their normal rate, without changing these fuses.

The transfer panel, which is the third from the right in Fig. 7, is similar in construction to the panels already described. It is, however, divided into two portions, the vertical strips being discontinuous. Moreover, the horizontal rods instead of being provided with a single contactor each are provided with six. The first 12 horizontal rods in each half of the board are connected to horizontal rods from the battery panels, all positives going to the upper half of this panel and all negatives to the lower half. It is, consequently, impossible to connect the same vertical strip to the positive and negative terminals of any one group of cells. The next four horizontal rods are connected to the terminals going from the two-phase generator through the switchboard shown in Fig. 1. The 80 pairs of vertical strips in the transfer panel are connected to the knife switches in the left-hand panel of the same board, and from these switches connections go to every room in the building.

A rear view of this switchboard is shown in Fig. 8. It will be seen that the wires coming from the storage batteries are run in conduit made up of sheet steel. As before mentioned, these battery wires are rubber-covered and lead-incased. The wires used for cross connections between panels are covered with white slowburning insulation. The panel to the extreme right in Fig. 8 has the outgoing wires also inclosed in steel conduit. This was not in position when the photograph was taken.

All of the switchboards in the building have their tops and ends closed in with sheet steel, so that the back of the board is in a compartment entirely closed from the room. In case of any fire through short-circuits or otherwise, it would be impossible for the flames to spread outside

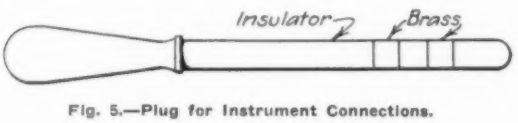


Fig. 5.—Plug for Instrument Connections.

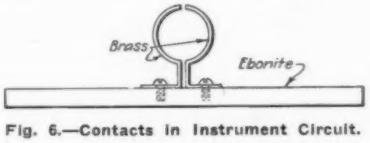


Fig. 6.—Contacts in Instrument Circuit.

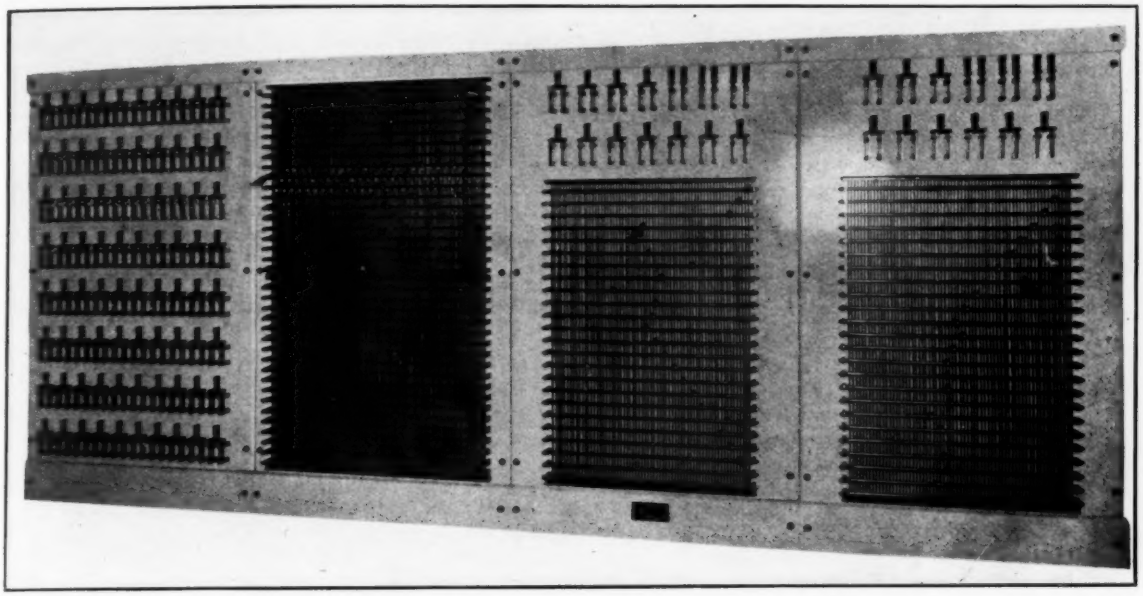


Fig. 7.—Front View of Switchboard No. 1.—Storage Battery Panels.

of this compartment and the fire hazard is thus reduced to a minimum.

Room Equipment.

From the distributing panels described above, circuits are run in conduit to the various rooms used for experimental purposes. As mentioned, the high-voltage circuits are in separate conduits. A third set of conduits carries the wires for lighting and power. A fourth set is used for the emergency exit lights, while a fifth contains the telephone wires. There are

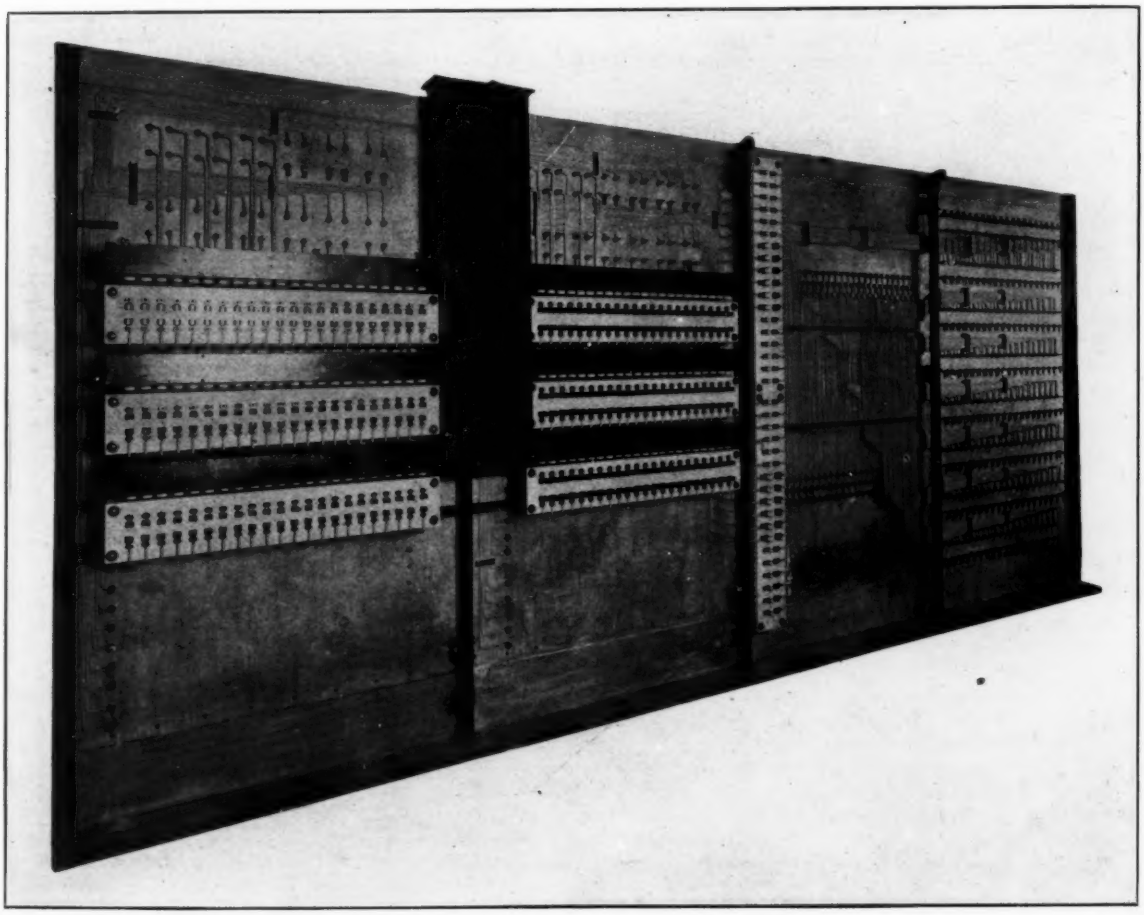


Fig. 8.—Rear View of Switchboard No. 1.—Fuses and Connections for Storage Batteries.

thus five sets of conduits used to carry the various circuits around the building.

The circuits to be used for experimental purposes end in each room in one or more steel equipment boxes. These vary somewhat according to the number of circuits brought out in the particular room, but consist in general of a panel containing a switch for each circuit to be brought out. These switches have binding posts as terminals and connections from the latter are made either to flexible leads which are brought into the equipment box through bushings or to another set of binding posts connected to permanent distributing circuits which are run to other outlets in the room. In each equipment box to which a high-voltage circuit is brought there is provided an oil switch. In each equipment box there is also a three-point receptacle connected to one of the telephone circuits. Portable telephones are provided for use in any part of a room and can be connected by plugging in to this receptacle.

The telephone system is of the automatic type and in addition to the permanent telephones in various parts of the building there are a large number of portable instruments and provision in all parts of the building for plugging these in upon a line running to the telephone switchboard. Electrical contacts in a standard clock can be connected to a telephone line so as to get time signals in any part of the building.

The switches in the equipment boxes are all fused. Provision is also made in these boxes for power circuits supplying both direct and alternating current. These boxes measure about 30 by 24 by 15 inches.

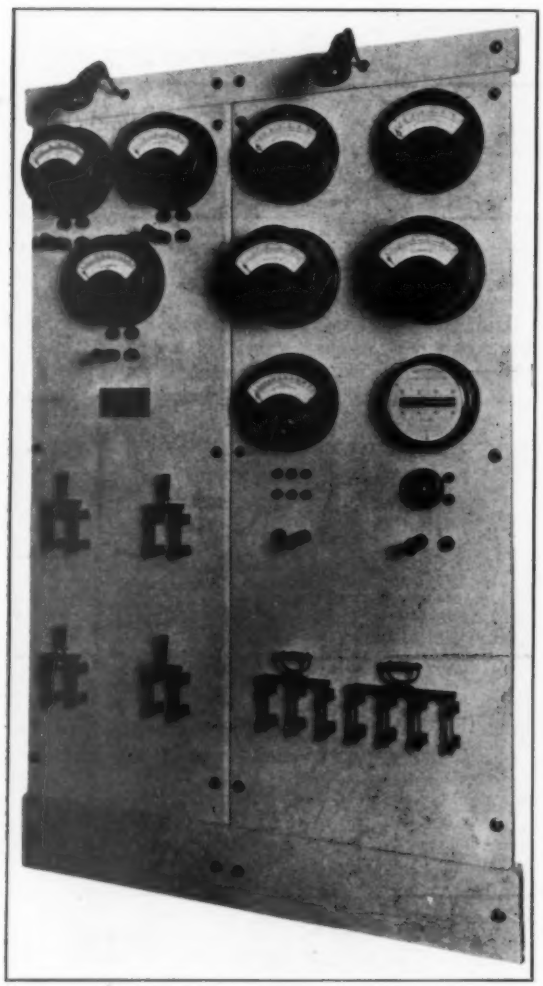


Fig. 9.—Switchboard in Lecture Room.

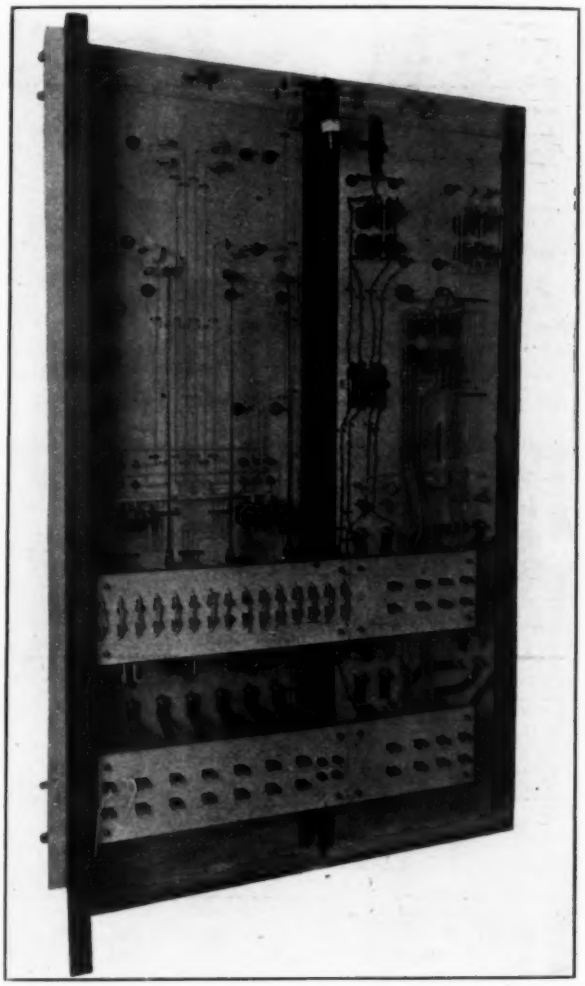


Fig. 10.—Rear View of Same Switchboard.

In the main lecture room a switchboard is provided, as shown in Figs. 9 and 10. This controls circuits leading to the lecture table and the instruments shown can be connected in any one of these circuits by means of a special set of plugs and sockets. Under each instrument in the left panel of Fig. 9 will be seen four sockets or jacks. These instruments are an ammeter, a voltmeter and a wattmeter. Only the handle of the plug is visible from the front of the board. The body of the plug consists of a straight rod of insulating material containing near the end two or three bands of brass insulated from one another, as shown in Fig. 5. When the plug is in position these bands make contact between the brass strips which are mounted behind the board on a piece of ebonite, as can be seen in Fig. 10. A detailed drawing of these brass strips is shown in Fig. 6. In the case of the ammeter and voltmeter two contacts are necessary and the plug, consequently, has two brass bands, as shown in Fig. 5. In the case of the wattmeter three bands and three sets of contacts are provided. A frequency meter, shown in the right-hand panel of Fig. 9, is of the vibrating-reed type made by Hartmann and Braun. All other instruments shown on the switchboards have been provided by the Weston Electrical Instrument Company.

For operating the lantern in the lecture room, a special circuit is provided which ends in a cabinet at one end of the lecture table. Flexible cable runs from this cabinet to the lantern itself and a rheostat is connected in the cabinet. In order to con-

trol the lights in the room from the lecture-table, a remote-control switch is provided, which can be controlled from this point. The switch itself is located in the cutout box, which is in another room upon the same floor. All lighting circuits for this room are connected through the remote-control switch before going to wall switches in the room.

The blackboards in this room, as well as in the other class rooms of the building, are provided with special lighting. Frosted tungsten lamps are mounted in sheet-iron troughs which are suspended from the ceiling. These troughs are open on the side towards the blackboard and their interiors are painted with white enamel paint. The lamps are mounted about 14 to 18 inches apart and are supplied from an outlet on the wall.

An electric freight elevator is provided in the building. This is of the Otis type and is controlled by means of push-button switches in the car itself, and at each floor.

Prof. Carl Kinsley, of the Physics Department, planned the equipment which was provided for this building. The construction work was done by Kohler Brothers, of Chicago, the switchboards being designed by C. L. Eaton of that firm.

New Wiring Rule in Cleveland.

M. Sarbinsky, city electrician of Cleveland, O., issued last month to the contractors of that city a notice calling attention to the interpretation which would be placed upon the Code rule requiring that the load on any branch circuit for electric lamps be limited to 660 watts.

In applying this rule not more than 12 outlets per circuit will be allowed. Furthermore, the wattage of outlets will be computed as follows and the total wattage on this basis must not exceed 660:

Apartments and Dwelling Houses.—Center and side outlets in third floors, basements, porches, bathrooms, closets, pantries, upper halls and vestibules, 40 watts each; side outlets in all other rooms, 40 watts each; center outlets in bedrooms and in kitchens, 60 watts each; center outlets in all other rooms, 150 watts each; baseboard receptacles, 120 watts each; drop cords, 40 watts each.

Stores.—Center-fixture outlets, 200 watts each; side-fixture outlets, 120 watts each; drop cords, 100 watts each; all other single socket outlets, 60 watts.

Toledo Cabinet Requirements.

The rules for electrical inspection in Toledo, O., require that the bottom of all cutout cabinets shall have a slant towards the front of about 30 degrees. The object of this provision is to prevent the cabinet being used as a convenient resting place for odds and ends.

Chicago Inspection Department Celebrates Anniversary.

The thirtieth anniversary of the passage of the ordinance creating the Bureau of Electrical Inspection in the City of Chicago was celebrated on the evening of December 10 by a banquet at the Planters Hotel, Chicago.

Inspection in Chicago was begun in 1880 by one inspector in the office of the Superintendent of Police Telegraph, the annual expense amounting to $1,000, but a separate department was not created until 1883. At present there are 67 men in this department, with a payroll of over $100,000 per annum.

A gold star was presented to Victor H. Tousley, chief inspector.

At the banquet silver stars were presented to all inspectors who had been in the department more than 15 years. There were six of them.

Speeches of presentation were made by Edward B. Ellicott, electrical engineer of the Sanitary District, and responses made by Mr. Tousley and others. Guests at the meeting were Ray Palmer, city electrician, William Carroll and Edward B. Ellicott, both former city electricians.

Telegrams of congratulation were received from Thomas A. Edison, H. H. Hornsby and others.

Among the Contractors.

The Lippincott Electric Company, of Bellefontaine, O., has completed the electric wiring for the lumber mill of A. Le Sourd & Sons in that city. The equipment included 13 Allis-Chalmers three-phase motors, varying in size from 2 to 20 horsepower, the wiring for which was done in iron conduits. The wiring for lamps was run in metal molding. Another job which was done by this company was the wiring of the Cozy Theater, the first theater in that city to be wired in conduit.

The West Coast Engineering Company, Portland, Ore., has received an order from the Booth-Kelly Lumber Company, of Eugene, Ore., for a complete installation of power and lighting in its new electrically driven sawmill now being erected at Springfield. The installation will consist of motors totaling about 2,500 horsepower, part of which will operate at 2,200 volts and part at 440 volts, all being of the three-phase induction type. A three-unit monorail system will be installed in the yards for handling lumber. Direct current for this will be provided by a 100-kilowatt motor-generator set.

H. P. Foley Company, electrical contractors of Washington, D. C., has the contract for the electrical wiring in the following buildings now under way: the Eastern Star and Masonic Home of the District of Columbia; the Harrington Hotel, a new six-story building; and the new 12-story Real Estate Trust Company office building.

The wiring for electric lights in the Hamilton County Court House, which has recently been completed at Chattanooga, Tenn., was done by Kluckhuhn Electric Company, of Washington, D. C. The switchboards and electric fixtures were installed by W. C. Teas, of Chattanooga, the fixtures being supplied by Horn & Brannen Manufacturing Company, of Philadelphia. The telephone wiring was done by Terrell-Hedges Company, of Chattanooga.

K. D. Slocum, of Clinton, Iowa, was awarded the contract for the wiring in the Mercy Hospital in that city.

The Brill Electric Company, of Spartansburg, S. C., has contracts for wiring the new store of the Woolworth Company; a church at Sanford, N. C.; a large office building in Clinton, S. C., and a school building in Bessemer City, N. C.

The B. & W. Company, Brookline, Mass., has been organized for the sale of electrical appliances and to do a general contracting business, the address being 1613 Beacon Street. J. Beaumont and W. H. Ward are the proprietors.

The new City Hospital building in Austin, Tex., will be wired by the A. E. Hancock Company, of that city.

The Sterling Electric Company, of Minneapolis, Minn., has contracts for the electrical work in an addition to the Dyckman Hotel and for the First National Bank Building.

The Axthelm Electric Company received the contract for the mercantile building being erected by Mrs. O. M. Johns in Pittsburgh, Pa.

The Turle Creek Electric Company received the contract for the residence of George Craven in Trafford City, Pa.

John J. Odenwald, who recently acquired complete ownership of the contracting business of the McQueen-Odenwald Company, of Washington, D. C., has a more central location and increased facilities in his attractive new place of business at 1204 H. Street, N. W.

The contract for the wiring of the lodge addition of the Knights of the Macabees in Pittsburgh, Pa., went to the Nickles Electric Company.

Dollar Wiring Kinks.

Every reader is invited to contribute to this column. It does not matter how few words are used to explain a "Dollar Wiring Kink," provided the idea is made clear; and if a diagram is necessary, a rough pencil drawing will serve. The idea itself must, of course, be new and bright. A dollar will be sent to the contributor upon publication.

Keeping Concrete Out of the Pipe.

I first made some hollow punches of the proper size and then secured some old pasteboard signs which had been paraffined on one side and cut several hundred disks from them by means of the punch, so as to have a supply on hand. These disks were of such a size as to just fit inside of bushings of the regular sizes, such as one-half inch, three-quarter inch, etc. The paraffin keeps water from soaking through and this method of plugging the end of the conduit is not only a good one but it is also cheap. It is not absolutely necessary to take the bushing off to take out the paper, for it can very easily be cut out.

W. M. Voss.

Fishing With a Drill.

I was recently called upon to wire a flush receptacle in a show window. There were three thicknesses of board about six or eight inches apart to bore through. The holes, through which flexible conduit was to be run, had to be bored at an angle and it was impossible to drop a fish chain through. To overcome this difficulty I pushed a bell-hanger's drill through one of the holes and had my helper slip the conduit over the end of the drill about four inches and then the fishing was very easy. The conduit in this case was one-quarter-inch flexible.

K. S. Wonderly.

Cutting Off Crowded Conduits.

Not long ago I had a job where a panelboard was to be replaced by a new one of larger size. It was necessary to cut off a length of about one foot from the conduit. Being an old installation the wires were all in place and it was not permissible to cut off the lights for any length of time. I therefore made the following special tool to cut off the conduits. I took a piece of steel one-half inch wide and one-eighth inch thick and bent it double. At the open end I put in a tap screw to hold the two parts together and at the other end a small pin to prevent the saw blade from slipping in too far. I then took a piece of a hacksaw blade and put it in between the two pieces of the steel with the teeth projecting out just far enough to reach through the wall of the conduit. It was then clamped. With this tool I proceeded to cut off the conduits, and by cutting nearly all of the way around it was possible to break them off. The conductors were still inside of the conduits. I then used a hollow reamer which I had constructed and reamed the rough edge. I have also found this saw very convenient in my tool kit for sawing flexible cable and various other things. It replaces the usual hacksaw frame; it is handier and results in fewer broken blades.

E. Kalkau.

Bending Conduit.

A good way to bend conduit is as follows: Get a carpenter's sawhorse and two strong planks and fasten the planks as shown in the figure. Conduit up to

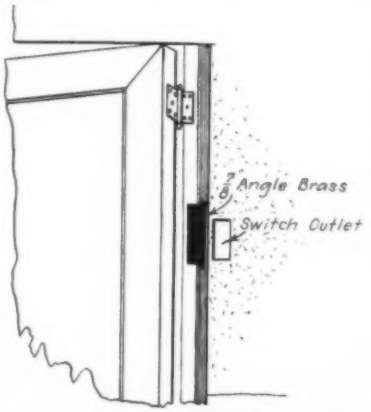
Bending Conduit.

one inch in diameter can be bent very readily by this method and I can make any kind of a bend that may be required.

W. W. Weller.

Preventing Injury to Door Casing.

A practical and convenient method of preventing injury to the corner of a



Angle Brass To Protect Casing.

door or window casing, when cutting in a switch close to it or when pulling in wire, is to fasten a piece of angle brass about eight or ten inches long over the corner, as shown in the illustration.

W. E. Griswold.

Testing Fixtures.

When hanging fixtures or testing them where there is no current on the circuit, connect a bell and battery across the mains and fuse the circuits. You will know as soon as a short-circuit occurs and can also test the fixtures to make sure that the splices and everything else are all right.

W. Roney.

Another Way of Testing.

A convenient way to test fixtures, chandeliers, etc., is with a magneto and a bell or buzzer mounted in a case with a handle. To the terminals attach a considerable length of lamp cord and an attachment plug to screw into the sockets. First the socket is turned on and if there is no ring there is no short-circuit; next two main wires are touched together at the top of the fixture. If the bell rings there is no open circuit. Next, one of the wires is touched to the fixture stem or crowfoot and if there is no ring there is no ground to the stem. All of these tests can be made without removing the plug. If the fixture has several sockets, each may be tested for open circuit.

Harry L. Metcalf.

Testing Intercommunicating Telephones.

I was recently called upon to repair an intercommunicating telephone system but had no helper along to assist me. By the following scheme I managed to work alone. I took the receiver of one telephone off the hook and hung my watch in front of the transmitter. I could then go to the other telephones and work on them and could listen to the ticking of the watch to tell when they were working.

Sim Naylor.

Substitute for Pipe Wrench.

On a conduit job my pipe wrench broke and I found that an ordinary monkey wrench will work if used with a piece of a rat-tail file. First screw up the jaws of the wrench on the pipe; them put the file in between the pipe and the jaw nearest to the handle of the wrench. In turning, the file will prevent the wrench from slipping.

F. Husar.

Sharpening a Twist Drill.

I have tried different ways of sharpening a twist drill so that it would drill marble faster than a drill sharpened in the ordinary way. I like the following style best of all. Just sharpen the drill as you would a cold chisel and you will find you can drill three times as fast with it as before. It will also stay sharpened longer and will not bind in the drill hole.

Paul C. Axline.

Public Service Commissions

NEW JERSEY.

The Board of Public Utility Commissioners has disapproved of a proposed sale of $620,000 North Hudson County Railway bonds by the Public Service Railway Company to the Fidelity Trust Company of Newark. The bonds bearing five per cent were to be sold at 97 per cent of par value, and the refusal of the Board is based primarily upon the point that a higher figure might have been obtained; it was further alleged that favoritism in denying competitive bids was shown. In its decision the Board says:

"'The Board is of the opinion that if a novel and unseasoned security were being floated in a large amount, the returns on which were experimental or problematical, the company's decision to accept a bid at what seemed a reasonable price, without subjecting itself to the risk of failing to obtain by competitive bids a market broad enough to absorb the entire issue, might under appropriate circumstances be wholly unobjectionable. But the bonds to be issued for this refunding belonged to a class of closely held, high-grade, thoroughly seasoned and well secured bonds. Inasmuch as any amount received for the refunding bonds less than par must be amortized during the life of the bonds, an additional burden by just this amount is imposed upon the patrons of the company, and an additional barrier by just this amount is interposed between the company's shareholders and their dividends. In the concrete evidence we are of opinion that the sounding of other possible or probable bidders was a necessary part of the proper course to pursue; that departure therefrom in similar circumstances, even admittedly made without consciousness of improper motive, is a policy that may lead to unwarrantable prejudice to shareholders and to customers, and that a sense of special obligation would warrant nothing more than the sale to the preferred bidder at as high a price as offered by another responsible party."

OKLAHOMA.

A proposed order has been issued by the Corporation Commission, addressed to all telephone companies operating in Oklahoma, having any verbal or written agreements with connecting companies for the transmission of toll or long-distance messages requiring them to make remittance to such connecting company for all such business on or before the twentieth of the succeeding month. They are also required to continue their connections until such time as they might be relieved by appeal to and order of the Commission. The Commission set January 13 as the date for hearing any objections or complaints from the companies affected in regard to the order.

The Commission has made a final order in the telephone case from Ada, reducing rates for business telephones, special line, from $2.50 to $2.00 per month; business, extension or private branch sets, left at $1.00; residence, special line, cut from $1.50 to $1.00; residence-two-party, from $1.25 to 75 cents; residence, extension, left at 50 cents a month. In this case the Commission acted under the new law giving it authority to make rates for public service utilities based on a fair and reasonable return on the investment. It had made an extended investigation into the original cost of the exchange, cost of operating and other items to be considered in figuring net profits. The Commission in its order found that the Pioneer Company has an investment of $63,869.13 in the plant at Ada; that for the year ending June 30, 1911, the gross income was $17,247.45, and that after expenses of every kind were met there remained a net income of $7,808.64, or 12.2 per cent on the investment. In view of that finding the reduction in rates was ordered.

WISCONSIN.

The Darlington Electric Light and Water Power Company has been authorized to abandon its present schedule of rates for electric lighting and to substitute the following: primary rate, 9 cents per kilowatt-hour for the first 40 hours' use per month of the active connected load; secondary rate, 7 cents per kilowatt-hour for the next 60 hours' use of the active connected load; excess rate, 4 cents. The company applied for rates ranging from 12 cents per kilowatt-hour for the first 100 kilowatt-hours per month to 5 cents for all energy used in excess of 600 kilowatt-hours per month. In lieu of a minimum bill of one dollar per month, as applied for, the utility is empowered to collect a minimum bill of 50 cents per month for an installation of 500 watts or less, plus a charge of five cents for each additional fifty watts. All lighting consumers are divided into classes A, B, C, and D in accordance with the practice of the Commission in fixing the percentage of active connected load. The order authorizes the utility to establish a power schedule consisting of a charge of 75 cents net per month per active horsepower capacity, plus a rate of 4 cents per kilowatt-hour for current used. The percentage of connected load to be deemed active varies from 90 per cent of the first ten horsepower connected to 50 per cent of all over 60 horsepower.

In its decision in the Waukesha Gas and Electric Company's case, the Commission ordered the utility to establish a schedule of rates for electric lighting which are materially lower than the rates at present in effect, and which are designed to develop the company's business in the way of increased lighting consumption. The utility applied for an increase in rates for both gas and electric service on the ground that the present revenues were inadequate to yield a reasonable return upon the investment. An analysis of the company's business over a period of years showed that the utility as a whole was not earning a reasonable interest on the investment and that the electric department, with the exception of the last two years, has earned very little. A material allowance was claimed for going value. Although there was merit to the contention on the basis of insufficient earnings in the past, the Commission disallowed the claim on the ground that "it would be an injustice to force the consumer to bear the costs resulting from what might be termed the neglect of the management to properly stimulate the sale of the utility's product." The decision notes that the petitioner is controlled by the American Gas Company, a company primarily interested in the gas business. It appears that, with the possible exception of the last two years, the company has directed its effort toward the extension of the gas business and nothing has been done to

further the sale of electricity. Today, the company's gas business is one of the best developed in the state, while its electrical business is one of the poorest. The limited number of lighting consumers and the small consumption per consumer are attributed to the high rates and to the failure of the company to properly stimulate the sale of electricity for lighting purposes. Attention is called to the fact that the power service, with a consumption of over 5.5 times that of lighting, contributes only nine per cent more to the total revenues, with the result that the burden is felt by the lighting consumers. The following rates, termed "development rates," are prescribed in the order: primary rate, 12 cents per kilowatt-hour for the first 30 hours' use per month of the active connected load; secondary rate, 9 cents per kilowatt-hour for the next 60 hours' use per month; excess rate, 6 cents. The consumers are classified according to the percentage of connected load deemed active as in previous decisions of the Commission. The present rates for lighting range from 15 cents per kilowatt-hour to 10 cents per kilowatt-hour.

An investigation of the company's gas business revealed the fact that the utility is selling gas at a loss to consumers using 2,000 cubic feet and less per month and that, furthermore, this group of consumers uses over 66 per cent of the company's product. The schedule of rates prescribed for gas service is designed to keep the present revenues intact but to eliminate certain objectionable features of the old schedule. The rates are to range from a charge of $1.20 per 1,000 cubic feet for a consumption of 10,000 cubic feet or less per month to a charge of $0.70 for gas used in excess of 100,000 cubic feet per month.

On the basis of last year's sales, the above schedules will effect a slight increase in the gas revenues, due to an increase in the minimum bill, but will cause a reduction in the earnings of the electric department. The present value of the company's property is given as $386,416 and the cost of reproduction, $456,143.

Among the Supply Men

The Pettingell-Andrews Company, Boston, Mass., reports that H. W. Wright is conducting a vigorous campaign for the sale of Hurley washing machines and vacuum cleaners, for which it is the New England agent. The company will issue a new catalog on January 1. It has been recognized that much depends upon the arrangement and indexing system of a large catalog and for this reason a great deal of time and thought has been given to it. The company feels that the result has justified the increased expense that it has been put to in working out an indexing system as nearly perfect as possible. G. C. Conner, formerly of the engineering department of the National Quality Lamp Division of the General Electric Compny, has recently joined the sales department of Pettingell-Andrews Company. Mr. Conner will have charge of the sale of Peerless Mazda lamps. W. E. Phinney, formerly Boston manager of the Eveready Company, is now with Pettingell-Andrews Company in charge of the sale of "Eveready" material.

W. H. Nolker, vice-president of the Commercial Electrical Supply Company, St. Louis, Mo., states that the company is conducting a campaign on Emerson fans and Westinghouse Mazda lamps. Business is good, although salesmen report the outside territory rather quiet. Christmas novelties are moving well as a seasonable product. The company will hold a sales conference early in January.

The Central Electric Company, in the December issue of the Electron, the bright little bulletin published by this company, presents a number of interesting items relating to steam railway car lighting, indirect lighting in a coal mine, electricity in the country home, a typical installation of Central ornamental lamp posts, the half-watt-per-candle Mazda lamp, and some philosophy with respect to increasing the factory output. The Patterson window sign, a unit letter illuminated miniature sign that is attracting considerable attention, is also illustrated and described. The cover page is a work of art suitable for the holiday season in three colors.

Front Cover of "Electron."

Mr. G. M. Stuart, treasurer of the Stuart-Howland Company, Boston, Mass., states that sales have largely increased notwithstanding some of the less favorable conditions which have prevailed in the trade throughout the territory this company covers. Within the last year seven traveling salesmen have been added to the sales force. The company has been specializing on line material, fixtures, Mazda lamps and electric heating material.

The James Clark, Jr., Electric Company, of Louisville, Ky., has sold a 30-kilowatt generator, direct-connected to a Skinner engine, to the Frankfort, Ky., Water Company. The company will use the equipment in operating motors which will drive the agitators, lifting screens, etc., at the new filter plant of the water company.

Increased Ambulance Service for London.

According to our British contemporary, *Electrical Engineering*, the Metropolitan Asylumns Board of London proposes to incur an expenditure of $93,400 in the establishment of an electric ambulance service throughout its area, similar to that now in use in the City of London. The London County Council is to bear a portion of the expenditure.

The Society for Electrical Development.

As the result of an intensive campaign upon the part of the Board of Directors, the greatest degree of enthusiasm has been aroused throughout the electrical industry in the growth of the fund of the Society for Electrical Development. Plans are well under way for the establishment of local committees in 17 of the principal cities for rapidly closing the subscription campaign. The minimum fund of $200,000, with which the Society contemplates beginning its campaign of education is about to be realized. Committees have been established at Boston, Philadelphia, Chicago and St. Louis as a result of the visits of H. H. Cadmore to these cities, alining the electrical interests under the banner of the Society.

The endorsement given to the Society by leaders in the financial world and the electrical industry is unique. Among others who have testified to their faith in the desirability and necessity of the movement the following are perhaps of the greatest interest, because of their prominence in their respective circles of endeavor:

Dr. Charles P. Steinmetz, the eminent inventor, scientist and philosopher, says:

Co-operation is now the basis of prosperity; competition, which has started our industrial progress, has become destructive and harmful to progress, if not limited and restrained by co-operation as the great economic force of modern industrial progress.

If your Society can help in bringing this about in electrical development it will have accomplished much, for in that field lays a great future.

Dr. Elihu Thomson, who, for many years has occupied a leading position as teacher, inventor and designer, writes:

I believe that the Society for Electrical Development has a great field before it in harmonizing interests and preventing ruinous competition by the methods which imply co-operation and mutual understanding. To do this effectively will, of course, require wise administration and a sympathetic attitude on the part of those connected with our industry. I have no doubt that if these are secured the benefits which may accrue will go far to counteract many of the difficulties under which business is at present conducted, and tend to the future development in the most healthful and hopeful way.

E. M. Herr, president of the Westinghouse Electric & Manufacturing Company, whose interests so intimately lie in the development of the industry, says:

Referring to letter of the 13th instant from Mr. J. Robert Crouse, the aims and purposes of the Society for Electrical Development have greatly interested me from their inception and I have watched your progress in this work with a great deal of interest.

I can assure you of my feeling that the purposes and aims of the Society, as outlined in the pamphlet which accompanied Mr. Crouse's letter, cannot help but be of great advantage and value in the development of the electrical business.

I have recently returned from a short trip in the east and have been very much interested and pleased to see the slogan "Do It Electrically" prominently displayed in many places.

Than Theodore N. Vail, president of the American Telephone & Telegraph Company, there are few men closer in touch with world movements, and their functions, in the development of the industry. Mr. Vail has this to say of the Society for Electrical Development:

Co-operation is the most effective factor of prosperity. Rational competition with co-operation is constructive and progressive, and is the only cure for our present evils and the only hope of the future.

Thomas A. Edison found time to give the plans submitted to him by J. Robert Crouse a careful analysis. In his characteristic vein Mr. Edison wrote to Mr. Crouse as follows:

I have been greatly interested in perusing the pamphlet dealing with the principles, plans and methods of membership of your Society, and am much impressed with the wisdom displayed in its conception.

It is indeed remarkable that, in a business of such phenomenal growth and having such keenly competitive interests, there could be evolved a plan sufficiently comprehensive to at once bring about an incalculable increase of business to the good of all concerned while not in the last disturbing the benefits of proper competition.

If the objects of your Society are carried out as now proposed I think the next few years will show an enormous advance in the use of electrical devices.

Frank A. Vanderlip, president of the National City Bank of New York, who is in close touch with the needs of the electrical industry from an investment viewpoint, endorses the Society in the following words:

I believe thoroughly in the purposes of the Society for Electrical Development. It is founded on right principles and it is constructive in every way. It is based upon the theory of broadening the scope of its members' activities and not of being in any way detrimental to one for the benefit of another. At the same time, its own success is so involved with good service to the public that mutual advantage must be derived from its activities. From the extension and the enlargement of central stations and the broader dissemination of electrical service, much economy directly beneficial to the public can be effected. In the education of the public along the line of increasing electrical facilities, diverse load factors can be obtained and service thus greatly cheapened. I believe the Society, while based upon the natural desire for more business for its members, is at the same time doing real public service, and it should receive hearty support.

H. B. Thayer, president of the Western Electric Company, says:

Co-operation between the various elements of the electrical industry, such as the Society for Electrical Development proposes, is a broad and comprehensive undertaking, and if it is in any measure successful, should be of much value to the central stations, manufacturers, distributors and contractors in the electrical business.

It is, therefore, with much interest that I will follow the development of the Society, with best wishes for its success.

E. W. Rice, Jr., president of the General Electric Company, one of the earliest members of the Society, is emphatic and enthusiastic, in his endorsement:

I am in hearty sympathy with every practical effort to extend the electrical business, and it would seem obvious that valuable work may be done along the lines proposed for the new Society. The electrical industry as the latest comer in the industrial field should lead in new-business methods. All electrical workers, including competitors, have manifold interests in common; all are vitally interested in finding new fields to cultivate, in the reduction of waste, the promotion of honest business methods and the formation of correct public opinion.

While many have come to the conclusion that under modern conditions there is a necessary limit to the old competition, all will probably agree that there is no limit to the new competition—the competition in co-operation.

J. B. McCall, president of the Philadelphia Electric Company, one of the largest central-station members of the Society, and president of the National Electric Light Association, has written a splendid endorsement:

The object, underlying principles, and plans of the Society for Electrical Development appeal strongly to me as representing essential progress and refinement in more efficiently extending

electrical service. The fact that selling costs of different branches of our industry, particularly the competitive branches, are either stationary or tend to increase from year to year, is a matter that warrants serious consideration for improved efficiency in distribution. This situation contrasts strongly with the tremendous strides made in research, engineering and manufacturing.

I believe that this trade movement will not only greatly facilitate the extension of our business, but will, in doing this, develop a spirit of harmony and co-operation within the trade and toward the public of the greatest possible value.

Our membership in the Society is our strongest endorsement, and we shall be pleased, in addition, to use our influence to have the central stations well represented.

Three Hundred Thousand Dollars to Fight Electricity.

At the convention of the National Commercial Gas Association, held at Philadelphia, December 4, plans were outlined for the invasion of every avenue of modern illumination by the gas interests of the country. A war fund of $300,000 is to be used in a national campaign of advertising on gas for municipal lighting and in the home. A great many new appliances that have revolutionized gas lighting and gas heating were described. A. H. Humphrey, of Kalamazoo, Mich., declared that because of the proficiency and economy of many other outdoor gas lamps that there will be a rapid increase in the use of gas for street-lighting purposes. A new plan of aggressiveness for procuring the outdoor lighting business was outlined. It was recognized that the gas company must furnish special units and connections for each installation. There is no building, however, it was declared, that cannot be equipped with an outdoor gas lamp. It was also recommended in the sale of outdoor lamps to stores and small business places, that they be sold upon the time-payment plan combined with rental, or upon the rental plan. Outdoor lighting, it was declared, has been revolutionized by the incandescent gas burner. The advent of electric light put the old-time open-flame gas lamp out of business, but now the incandescent lamp has come along and is going to be an ardent competitor of the electric lamp.

William F. O'Donnell, of the United Gas Improvement Company, spoke of the co-operation that should exist between the manufacturer of gas appliances and the gas company in advertising their service and material.

Surface combustion ovens of the flameless-burner type were demonstrated to the hotel and restaurant men particularly, along with water sterilizers, heaters, gas ranges of every style and character, etc.

In connection with the big publicity and advertising campaign, the declaration of Herbert N. Casson, advertising expert, of New York, is of interest. Mr. Casson said in part:

"Gas men began to make gas 30 years ago, and they have only begun to advertise. They are clever in their home towns, but they have been dead in a national sense. It is possible by national advertising to put gas in the electric-light class.

"Gas is canned sunlight, and the human eye was built for sunlight—not for lightning. That is what the sun is, a great big Welsbach light, and electricity is lightning. In Indianapolis they have changed from electricity to gas for street lightning at a big annual saving. They have found out that gas is best.

"We know what we are talking about—gas has no ultra-violet rays and electricity has, and ultra-violet rays destroy the sight. When you take an electric light bath, for instance, you cover your eyes, because electric light hurts them.

"Gas has come back; it is the great 'white hope.' Don't let them tell you gas devitalizes a room. It doesn't; it encourages fresh air to enter a room.

"Everybody is against you, the public thinks you are dangerous. You are not. They think you are expensive. You are not. Gas is cheaper than shoeshines. We know just how things go, and we are going to tell the people of the nation the truth. Nowadays if a gas man makes a mistake he is done for. Did you ever see a gas man elected to office in his home town? No, you never did.

"A lawyer can make a mistake, and he gets the case to argue over again. When a doctor makes a mistake he buries it. When a judge makes a mistake it becomes law, but when the gas man makes a mistake he is called a second 'Gyp the Blood.' We are going to change all that.

"We are not going to fight the public, we cannot fight it. The public is bigger than we, it gives us our life, and it can give us our death if we do not act fairly. Let me tell you that unpopularity in the long run is more expensive than advertising that makes friends.

"You are going to use the newspapers and magazines in this campaign. You cannot ignore them. You are going to win in this fight. Nothing is impossible. The San Francisco earthquake made every cripple in town run for three miles. Self-starters are what you all need."

Nitrogen Lamps for Panama Exposition.

It has been decided to use the new nitrogen-filled incandescent lamps for lighting of the small courts of the Panama-Pacific International Exposition. The lamps will vary in size from 1,500 to 5,000 candlepower.

PUBLIC RELATIONS.[1]

By J. H. Pardee.[2]

Some of us can remember the early days of street-railway development when the difficulties and problems which confronted the promoters and operators of traction properties were nearly entirely of a technical nature; the adventurers whose names shall always occupy prominent positions in the history of early railway construction were men of confidence in their own convictions that, in accordance with the fundamental laws of magnetism, mechanics, etc., the forces of nature could be successfully directed to the needs of transportation. The general public stood on the side lines, always interested to be sure in the progress made by those who were struggling with the adaptation of the electric motor to the propulsion of public carriages, yet assuming no particular risk excepting perhaps that which it considered involved in the granting by communities to tramway companies the right to erect poles and overhead wire in public streets for the distribution of the deadly electric current. The public during those years cannot be said to have considered itself as anything in the nature of a partner in the development of traction properties, but rather that the latter were being developed by outsiders who, believing it possible to successfully construct and operate street railways electrically, were willing to risk their fortunes and direct their energies to such development. The consent of the public was needed, however, since the streets were under its control; this consent was sometimes given in lieu of remuneration and in some cases free, in view of possible service for the benefit of the citizens and anticipated communal development.

Today, as we all know, the situation is very different; the public is indeed considered a partner in the management of the affairs of public service properties. Promoters may be confident that electric railways can be successfully built as far as the purely technical features are concerned; they must now make sure that their schemes have the approval of public opinion. Many have reaped handsome profits in this line of endeavor and some people, not familiar with electric railroading, and giving way to the very natural human instinct which directs one's criticisms at those who have been successful, have endeavored to sketch the successful promoters of public utility projects as highwaymen who bleed the public of its life blood by various methods among which they mention particularly the treatment commonly known as "watering of stock."

1 Address before New York Electric Railway Association, December 9, 1913.

2 President of the J. G. White Management Corporation.

In the discussion of present relations of public service corporations and the public, it is needless to include the pros and cons of past arguments regarding the proper position of each; the officers of street-railway companies are now bearing heavy responsibilities of the new phase of utility administration, this being the guidance of public relationship. Traction lines are public servants existing for the comfort of the people and bearing to them certain well defined obligations in the way of safe and adequate service at equitable rates; the public owes them fair treatment and protection from the indirect confiscation of their property by legislation, making it impossible to earn proper returns on investments in such property. Due to the failure of municipal ownership the public has found, after many costly trials of this inefficient method, that the most expedient and practical solution of the problem lies in the development of traction systems by private capital, together with proper and fair regulation by commissions representing the public interest.

It is certain that from this comparatively new system of utility regulation have come a great many abuses of the regulatory power. Prompted by an ill advised public opinion, and, in some cases ignorant of actual conditions, commissions have been known to impose upon electric railways very onerous conditions, limitations, etc., which have so seriously burdened such companies as to actually set back their development to a very considerable extent by inspiring the ever cautious money lender with fear. Unreasonable regulation can, in the long run, harm no one but the public itself, for it automatically, by the very laws of economics, increases the rate at which money can be drawn into this field of investment, and hence the rates which the public must pay for service. It is my confident belief that, in the abuse of regulatory powers, the pendulum has now commenced to swing back and that public service commissions are coming more and more to realize their obligations to security holders as well as to the sovereign partner, the public.

Having the greatest confidence in the general integrity of our American public, I believe most of the unfair burdens which have been saddled upon street-railway companies with the consent of public opinion have been the result of gross misconception concerning the affairs and conditions of operation of such companies. The greater part of the general public knows very little about the electric railway business and is easily misled by those who, being socialistically inclined, picture them as monstrous monopolies, turning over tremendous and unwarranted monetary returns to their owners. Most people have been decidedly misinstructed regarding watered stock and do not know or at least stop to think that street-railway companies pay taxes, offer and give employment to citizens and often pave streets and assist in the development of communities by offering industries cheaper power than could be generated in isolated plants of small capacity. On all these points the general public must be educated if street-railway companies are to obtain a cordial, harmonious relationship of co-operation with the public, which is the most valuable of all assets and the most difficult to obtain. It is only with the existence of this spirit that we may expect to be relieved of burdensome and unjust regulatory mandates such as those calling for unreasonable extension of fare zones, extension of lines into territory not offering sufficient traffic inducement, and the unwarranted rehabilitation of road and equipment.

In regard to obtaining such a relationship with the public you have already heard a great deal. You are all well acquainted with such methods as proper education through the medium of newspapers, fair treatment, endeavor to meet general service requirements and open ears to all complaints and suggestions of the public.

In conclusion I am pleased to say that I believe, in general, that public opinion has come to realize that it too must endeavor to establish a harmonious spirit of co-operation between street-railway companies and those whom they serve, in order to arrive at the very best result for all concerned, and also believe we may expect to see a great improvement along these lines in the very near future.

Indirect Lighting of the Home.

Through the courtesy of Augustus D. Curtis, president of the National X-Ray Reflector Company, a meeting of the Chicago Section of the Illuminating Engineering Society was held at Mr. Curtis's residence near Jackson Park, Chicago, on the evening of December 10. The house was thrown open to about eighty members, their ladies and friends, who inspected the beautiful lighting equipment of the various rooms on both floors of the building. This is almost exclusively of the indirect type and showed strikingly the adaptability of this kind of lighting to the varied requirements in different parts of a home.

Five kinds of indirect equipment were in use: pure indirect fixtures with opaque bowls both of the ceiling and bracket types; an indirect ceiling fixture with faintly luminous bowl; portable lamps for indirect lighting with a few small auxiliary lamps for direct lighting, these lamps being both of the table and floor pedestal types. A great variety of ornamental designs were represented in the fixtures, scarcely two of them being of identically the same pattern. All of the rooms were most attractively illuminated, an abundance of pleasant, glare-free light being provided in each apartment.

After a preliminary inspection of the lighting equipment, Mr. Curtis assembled his guests in his reception room and library and read a paper reviewing the progress of five years in the indirect lighting of the home. He recalled the similar visit made by the Chicago Section of the Society to his home five years ago, when the only kind of indirect fixtures used were of the ceiling-suspended type with opaque bowls. Now there are available also luminous-bowl indirect fixtures and portable table and pedestal lamps. Mr. Curtis described each of these types, which are familiar to the readers of this journal from recently published descriptions.

Mr. Curtis dwelt on the great advance of indirect illumination. When this was introduced in this country a little over five years ago, it met the derisive criticism and opposition of nearly all engaged in the lighting business. Gradually, however, it was installed in offices, theaters, churches, stores, hospitals, and similar public and private interiors. It has steadily made headway and converted former critics to enthusiastic advocates. Now it is being introduced in residence lighting, a field where its artistic possibilities are demonstrated by such an installation as Mr. Curtis has put into his home. He described each of the fixtures he has installed, gave the foot-candle illumination values obtained in each room, and pointed out the relation of wall and ceiling decoration and other features bearing on the use of different types of equipment. He called particular attention to the portable units and predicted their greatly increased use in relieving the walls and ceiling of fixtures entirely. By placing a light pink tinted celluloid screen over one of these portable lamps he showed how the illumination could be "doctored up" to enhance the complexion of the ladies, giving them a charming rosy effect.

Following the presentation of Mr. Curtis's paper there was a general discussion participated in by Chairman M. G. Lloyd, A. Scheible, I. K. Pond, of Pond & Pond, architects, J. R. Cravath, Drs. Black, Wilder and Brown, ophthalmologists, George C. Keech and Mr. Curtis. The speakers complimented Mr. Curtis on the excellence of the lighting effects produced and particularly on the restfulness of the illumination and its freedom from eye strain and glare; the artistic charm of the installation was also commented on.

Meeting of Commonwealth Edison Section, N. E. L. A.

The regular monthly meeting of the Commonwealth Edison Section, National Electric Light Association, was held on Tuesday evening, December 16, at the Hotel Sherman, Chicago. About 300 were present to hear the interesting paper read by Francis S. Peabody, president of the Peabody Coal Company.

Mr. Peabody, speaking on the general subject "Coal," went briefly into the geology of this fuel and illustrated the various features of formation and location of veins by stereopticon slides. Comparison was also made of the No. 1 mine which had a capacity of about 30 tons per day, and the present Nokomis mine from which 8,000 tons are taken in eight hours. This mine, Mr. Peabody said, is now the largest in the world, as well as the best equipped. The Nokomis mine is operated entirely by electricity, power being transmitted about 30 miles from the Kinkaid plant of the Public Service Company of Central Illinois.

A complete description was given of the electrical equipment at the mine, including the induction-motor flywheel generator set. This set will no doubt be remembered by readers of the ELECTRICAL REVIEW AND WESTERN ELECTRICIAN, on account of its unusually heavy steel flywheel, the energy of which is used in overcoming the frequent and heavy hoisting loads that must be cared for.

Moving pictures taken above the ground and in the mine, made the talk one of unusual interest. One scene particularly worthy of note showed very clearly the operation of the undercutting coal machine. Practically every important operation of coal mining as practised in the Nokomis mine was included in the two films which were shown.

Chicago Has Fine Jovian Rejuvenation.

One of the most satisfactory and enthusiastic rejuvenations ever held by the Jovian Order, was conducted under the direction of Statesman Homer E. Niesz at Chicago, Ill., on the evening of Monday, December 15. A class of 50 candidates was prepared to enter the Order, but owing to sickness and other inability but 37 presented themselves for initiation. The Chicago Jovians will hold a rejuvenation every three months and the 13 who have not been obligated will enter in the next class.

Mr. Niesz acted as toastmaster, introducing Reigning Jupiter W. N. Matthews, Alternate-Statesman E. H. Waddington, Past Jupiter Sam A. Hobson and Stentor Perry Boole.

The degree team, under the leadership of Captain Thomas Hawkins, conducted the ritual in a highly efficient and spectacular way, arousing the spellbound audience to a high pitch of appreciation and enthusiasm.

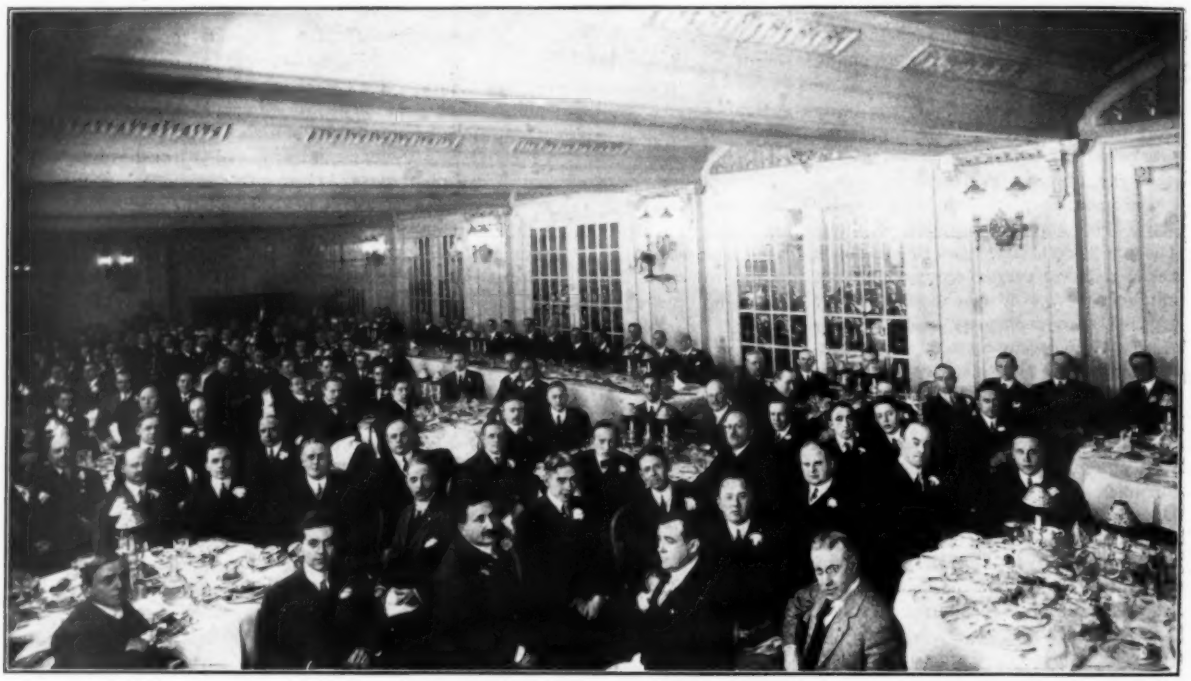
Following the initiation ceremonies there was a short vaudeville entertainment which was highly enjoyed.

London Supply.

A gigantic scheme for supplying electricity in bulk to London, England, by private enterprise will be submitted to Parliament for sanction next year. The power supply of London is now carried on by a number of separate companies and municipal plants. The new concern would not only provide power now furnished from these but would also provide electric power for a number of railways which are now considering electrification. Where existing companies are owned by private corporations the new company would take over the stock and issue shares in the new concern in exchange therefor.

Civil Service Examination.

The United States Civil Service Commission has announced an open competitive examination for laboratory assistant in the Bureau of Standards at salaries ranging from $900 to $1,200 per year. This examination will take place on January 21 and 22, 1914, at the usual places and will cover general physics, French or German, practical questions on certain optional subjects and education, training and experience. Each applicant will be examined in as many of the optional subjects as he may desire. These subjects are (1) electricity; (2) heating; (3) mechanics; (4) optics; (5) paper technology; and (6) textile technology. Applicants should secure Application Form 1312 from the office of the Commission, Washington, D. C.



Banquet of Chicago Jovians, December 15, 1913.

THE CHARACTERISTICS OF INSULATION RESISTANCE.[1]

By S. Evershed.

During recent years a great deal of valuable research work has been done to increase our knowledge of the properties of insulating materials, yet notwithstanding the progress so made the natural laws governing insulation resistance are but little understood. So little, that if at the outset of this paper a plausible statement were made to the effect that the insulation resistance of an electrical system depended mainly upon the dielectric properties of the insulating materials, it might easily pass unchallenged. Possibly some objectors might be found among those who have to maintain the insulation of electrical plant; for no one who has had much experience of the behavior of insulation in practice, could fail to be struck by the disparity between insulating materials under test in the laboratory and the same materials under the ordinary conditions of use.

It is, of course, easy to guess that the disparity is generally due to the presence of moisture, and in fact the only insulating materials whose behavior in use corresponds with their predetermined dielectric properties are those which are non-absorbent. Of the remainder, and they form the majority of the materials in common use, we can only predict that the insulation resistance of any electrical system in which they are used will be governed almost entirely by the moisture they absorb. Everyone knows that insulation resistance decreases on a damp day and recovers during dry weather. It is perhaps not so generally known that in most cases insulation resistance decreases, in a perfectly definite way and almost instantaneously, as the electric pressure upon it is increased, and slowly recovers if the pressure is restored to the initial value or cut off altogether. The connection between these two facts is by no means obvious, yet they are so closely related that if we succeed in explaining one of them we shall certainly understand the other. It is often useful to attempt to explain familiar things; facts which, like the effect of a damp day on insulation, are so natural as to require no explanation—until we begin to think about them.

What is the margin between the working voltage and breakdown? That is the fundamental question at the root of every inquiry into the properties of insulation. If a definite answer is ever forthcoming, it will not have been found in "blind" tests of breakdown voltage. To conduct tests without means for ascertaining what is going on in the insulator as the breakdown voltage is approached, without either observing the current, or better still, the resistance, is to shut our eyes and deliberately avoid looking for the cause of the failure.[2] The author has therefore sought, by investigating the nature of leakage conduction, to establish some definite relation between applied potential difference and insulating resistance. If the curve expressing this relation be traced from a few volts up to the breakdown point, it will be found to consist in general of two parts of opposite curvature more or less like the voltage-resistance curve shown in Fig. 1. The two parts of the curve will be

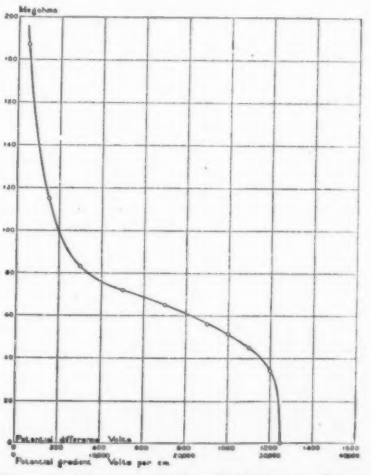


Fig. 1.—Characteristic Resistance Curve for Cotton Which Has Absorbed Moisture.

joined together by an approximately straight line, the length of which varies greatly according to the nature and condition of the insulation. This connecting link is sometimes so short that the two parts of the curve appear to meet at a point of inflection and they then form a sort of ogee curve.

The research had not proceeded very far before it was realized that the shape of the first part of this characteristic curve is determined by the extent to which leakage is due to moisture, and further that leakage through the substance of the insulator—dielectric leakage—was negligibly small compared with that caused by the merest trace of moisture. This leads to the point of view that for most practical purposes an insulator may be regarded as having no inherent conductivity, the conducting power which it appears to possess being usually caused by leakage over damp surfaces. If the insulator is porous then the leakage surfaces are not only those outside the insulating body but those surfaces which bound the maze of capillary channels inside the porous material. If this idea be provisionally accepted at the outset, the facts brought out by the experiments will be found to fall easily into their places, and a fairly constant view of leakage conduction will be obtained. The research divided itself quite naturally into two parts corresponding to the two significant parts of the characteristic curve. The investigation of the second or breakdown part of the complete curve is still in the preliminary stage, and the present paper deals mainly with the first part up to the point or region of inflexion.

Method of Investigation.

Methods of experiment will only be described so far as they are essential. As a preliminary, a few words must be said here in order to remove any misapprehension as to what it is that goes by the name "insulation resistance." When a conductor resistance is measured care is taken to avoid the introduction of any extraneous electromotive forces due to polarization, induction, capacity, or thermo-electric junctions. By so doing, the result of the test is a true measure of an inherent property of the conductor, namely the ohmic resistance apart from any other kind of resistance or opposition to the passage of an electric current. But with insulating materials similar precautions are not generally possible, and all that can be done is to measure the ratio of applied potential difference to the resulting current and call that the insulation resistance. We may measure the two factors either separately by means of a voltmeter and a galvanometer; or both may be measured at once by an ohmmeter. Either way the result is the ratio of pressure to current. It is customary to express this ratio in ohms or megohms, and there is no harm in doing so provided we realize that the "ohms" so obtained are not necessarily of the same nature as the ohms in a metallic conductor. Of course the true ohmic resistance of the insulator (if it has such a property) is included in the result of a resistance test, but it is so entangled with surface leakage, the effects of electrostatic capacity, and the penetration of electric charges into the substance of the insulator, that we are often obliged to be content to lump all these things together when we undertake the measurement of insulation resistance.

Resistances of very high value are often measured by charging the system under test and then observing the gradual fall of potential as the charge leaks away. But this method, being based on the assumption that the resistance of an insulator is independent of the potential difference, begs one of the principal questions the author set out to answer. Obviously it was essential to measure either the resistance or the leakage current.

1 Portion of a paper presented to the (British) Institution of Electrical Engineers.

2 The flash test as applied to some costly piece of electrical apparatus must have been inspired originally by something akin to the heroism of the savage.

In dealing with so unstable a quantity as insulation resistance there are obvious advantages in making direct measurements of resistance, and perhaps the greatest advantage of the ohmmeter method is the detection of instability immediately it occurs. But it was desirable to have the means of measuring up to about one million megohms at 500 volts, and at present the galvanometer is the only instrument possessing the required sensibility. The use of ohmmeters was therefore confined to tests which came well within their range, and the greater part of the work was done by means of a Broca galvanometer made by the Cambridge Scientific Instrument Company.

The galvanometer method gives no evidence of instability until the ratios of pressure to current are worked out at the conclusion of a series of tests, and the

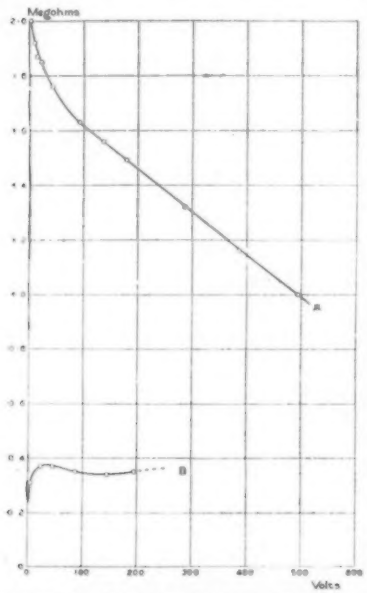


Fig. 2.—Insulation Resistance of Lighting Circuits in Dry (A) and Very Wet (B) Weather.

consequence of this lack of timely warning was that in many cases it proved to be impossible to plot a curve from the observations, just because the insulation had been in an unsteady condition during the tests. For this reason alone much fruitless labor would have been avoided had it been possible to use an ohmmeter throughout the investigation.

The pressure was supplied by a battery of secondary cells giving about 500 volts, and in a few cases this was supplemented by a small testing generator giving 1,000 volts. It should be mentioned that when leakage conduction is to be detected or measured, direct current is essential. Quite apart from the greatly inferior sensibility of alternate-current instruments, the alternating current due to electrostatic capacity is generally much larger than the leakage current, so that the latter is difficult to disentangle and easily escapes detection altogether.

Guarded insulation—the method of Price's guard wire extended to include every material insulating point in the testing apparatus—is now universal in insulation testing. This happy invention was of course used throughout the present investigation, and hence the current measured was in every case the current it was intended to observe and nothing else.

Typical Examples of Insulation.

Although it is impossible to predict the insulation resistance of any piece of apparatus, yet if each of the insulating materials had a resistance as constant as that of a metal we might reasonably expect the insulation as a whole to follow Ohm's law. A few typical examples will show how little ground there is for any such expectation. In the choice of examples it does not matter what kind of insulators are involved; so long as their resistance is within the range of measurement they will nearly all tell the same tale of a gradual fall in the resistance as the testing voltage is increased. Characteristic voltage-resistance curves, obtained from things which happened to be at hand, are given in Figs. 2 to 5.

It will be seen that the resistance falls as the potential difference rises, although the curves differ in shape a good deal and the decrease in the resistance is therefore much less marked in some cases than in others. These obvious variations in the curves indicate differences both in the kind of material used for insulation and the condition as regards moisture. The two curves in Fig. 2, one traced on a wet day and the other after a spell of dry weather, show that a large excess of moisture not only lowers the general level of the resistance but also brings about an entire change in the character of the curve. In the lower curve three things which are characteristic of conduction by moisture are struggling for the mastery. On a wet day every solid insulator is covered with a film of water which if it were in stable equilibrium would conduct according to Ohm's law and give a horizontal straight line. But instability is a marked feature of films when they are exposed to the air, and hence in practice the curve is never a simple straight line. In addition there is some typical conduction through absorbent insulators, and the curve is the resultant of all three effects.

Fig. 3 is remarkable because it shows that the resistance was affected by polarity. When the testing generator was so connected that the circuit wires were positive and the earth negative, the resistance was 8.7 megohms; whereas when the polarity was reversed the resistance fell to 5.7 megohms; both readings being those taken at 500 volts. This polarity effect is a strongly marked characteristic of earthenware insulators.

Before any general hypothesis can be framed to account for the characteristic behavior of insulation in ordinary use, it is clearly necessary to know something about the individual behavior of different insulating materials. For this purpose a brief outline will be given of the prolonged experiments that were made on a large number of materials which are in common use for insulating purposes. The materials included rubber, gutta-percha, micanite, porcelain, cotton, paper, silk, oils, and varnishes.

Figures may be found in the textbooks for the specific resistance of various insulators. What may be called good insulators vary from about 80 million megohms for mica up to about 50,000 million meghoms for vulcanized rubber—the centimeter cube being the datum.

The only non-absorbent insulators which were tested in the course of the work recorded here were gutta-percha and rubber. These are both non-absorbent in the sense that what little water they may be capable of absorbing is entirely unable to form leakage paths through the insulator. Submarine cables insulated with these materials have been lying on the

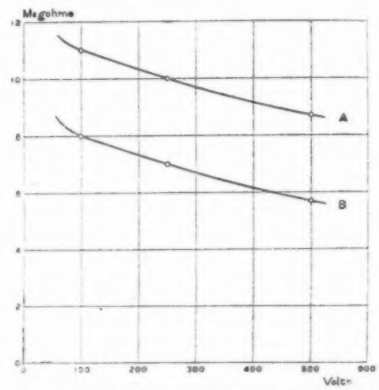


Fig. 3.—Insulation Resistance of Interior Wiring.

A, wires positive, earth negative.
B, wires negative, earth positive.

bottom of the sea for half a century or more, and, so far as the author is aware, no trace of conduction by absorbed water has been detected in a sound cable.

Rubber as an insulator for cables is so extensively used in every branch of electrical industry that it is naturally the example chosen for illustration. The test sample was a rubber-covered flexible cable made up of 64.6-mil wires, insulated in accordance with the standards of the Cable Makers' Association, and guaranteed to have an insulation resistance of not less than 600 megohms for one mile after one minute's electrification. The rubber is between 35 and 37 mils in thickness, and consists of one layer of pure Para and two layers of vulcanized rubber. A length of this cable—equal to one-sixteenth of a mile—was put into a bucket of water, where it remained for 40 days. The tests which

were made during that period consisted in charging the cable at about 500 volts and observing the total current flowing into it at intervals of time, so that a time-current curve might be drawn. Tests were also made by discharging the cable and observing that part of the discharge current which passed out through the galvanometer.

At one minute the total current was 0.0051 microampere at 525 volts, hence the value of what may be called the "customary resistance" was 103,000 "megohms" for one-sixteentl of a mile of cable; and the customary resistance of one mile of similar cable would be roughly 6,000 "megohms." The final value of the current being 0.00072 microamperes, the real dielectric resistance was 730,000 meghoms, equivalent to a dielectric resistance of 45,000 megohms for one mile of similar cable.

With these figures as a guide let us ascertain the relative importance of dielectric leakage and moisture leakage in some installation of interior wiring in which rubber-insulated wires are used. The circuits which gave the characteristic curve shown in Fig. 3 afford a good example, being carried out with rubber-covered wire insulated to the same standard. The conductors also are of the same diameter in the two cases. The installation contains 380 yards of wire, coupled up in the usual way to a number of fittings in which porcelain is used exclusively as the insulator. Assuming the covering of the wires to be undamaged, the dielectric resistance of 380 yards of wire to earth will be about 200,000 megohms, and the customary resistance would be about 28,000 "megohms." We need not attempt to decide which of these values is to be taken, because it is only necessary to look at Fig. 3 to find that the resistance of the installation as a whole was but a paltry 6 megohms, even when tested in dry weather. The relative importance is now obvious; leakage through the dielectric rubber is nothing, leakage at the fittings is everything.[3]

What has been demonstrated in the case of rubber must be equally true with regard to any insulator which has a resistance in any degree comparable with that of good rubber. The resistance of such materials as ebonite, sulphur, glass, mica, gutta-percha, shellac, dry paper, and dry cotton, is in every case enormous; like rubber their specific resistance is measured by millions of megohms, and in most cases by thousands of millions.

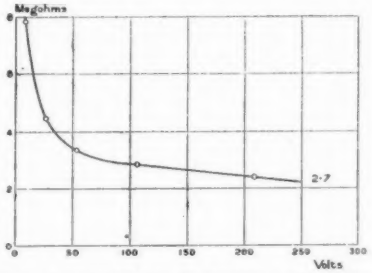


Fig. 4.—Insulation Resistance of Cotton With Normal Moisture.

Hence dielectric leakage will be ignored in what follows.

Moisture Curves.

Cotton.—Although this material is so largely used as an insulator for wires the opportunity for observing its resistance seldom or never arises in practice. Several test pieces were made up, each consisting of two cotton-covered wires wound side by side in a single layer on a well glazed porcelain bobbin so that leakage from one wire to the other could only take place through the cotton coverings. One of these cotton test pieces when tested for insulation resistance from one wire to the other gave the curve shown in Fig. 4. After being dried in an oven at 150 degrees centigrade for a couple

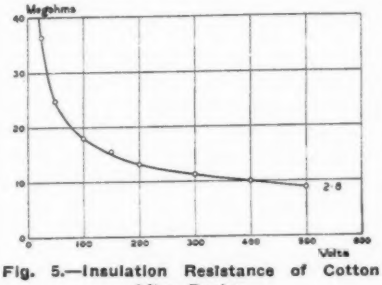


Fig. 5.—Insulation Resistance of Cotton After Drying.

of hours, and then allowed to cool, this test piece gave the curve shown in Fig. 5. The resistance is now five or six times greater as the result of the partial evaporation of the moisture originally contained in the cotton, but the general character of the voltage-resistance curve is unaltered. It will be noticed that at 500 volts the resistance has fallen to about one-third the value it had at 50 volts, or to put it shortly $R_{50}/R_{500}=2.8$. This is a rough-and-ready way of comparing curves which, although following similar laws, look very diffeernt to the eye simply because they are plotted to different scales. In the diagrams the value of the ratio R_v/R_{10v} is marked at the end of each characteristic curve so that different curves may be readily compared, and it is found that in the case of asborbent materials this ratio is more commonly nearer 2 than 3.

Paper.—Although cotton exhibits all the phenomena of conduction by moisture, it is not the most convenient material for experiment. Paper lends itself very much better to exact conditions as regards the area and length of the insulator interposed between the two conductors. Various kinds of paper under a variety of conditions as regards moisture, compression, length, and area, were exhaustively tested. The test pieces were each composed of several sheets of paper cut to a suitable size and shape and laid in a pile on a flat copper plate which served as one electrode. A second copper plate on the top of the pile of paper acted as the other electrode, and by putting the complete test piece in a small screw press any compression could be obtained, from that due to the weight of the upper electrode to about 100 pounds per square inch. As might be expected, paper behaves in much the same way as cotton.

The law of the characteristic curve is considerably affected by the degree of compression to which the absorbent material is subjected.

The degree of moisture in an absorbent material, like paper, may be varied within wide limits without much affecting the law of the moisture curve, although the corresponding variations in the resistance will be enormous. But when the material contains a considerable excess of moisture, so that it is sensibly damp, the law begins to change; the ratio R_v/R_{10v} gradually approaching unity as a limit and the curve subsiding into a horizontal straight line. In other words when an absorbent insulator is sodden with water its resistance follows Ohm's law.

Micanite Cloth.—The test pieces for examining this material were made up by wrapping a single thickness of the cloth around a piece of smooth iron pipe, and then winding a single layer of cotton-covered wire tightly over it. The cloth was therefore tested under much the same conditions as are commonly met with in practice, micanite cloth being largely used as an insulator for windings. Of course, in ordinary use there may be leakage over the surface of the cloth in addition to that which takes place through the insulating material; but as it was intended in these experiments to investigate conduction *through* the micanite apart from any other leakage, guard wires were tightly twisted round the cloth which projected beyond the winding at each end of the test piece.

One of these test pieces, immediately after being wound and before being dried, indicated conduction by moisture. The rather low resistance suggested that there was a good deal of water absorbed in the

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3 It may be remarked in passing that the average resistance per leakage point is a useful criterion for the insulation of wiring. In the case of the resistance from wires to earth, the switches, fuse blocks, ceiling roses, lampholders (if they can leak to earth), and other places where the conductors are fastened to leaky insulators, constitute the leakage points. For resistance between the wires with the switches closed and the lamps removed, the lampholders alone are to be counted; and for resistance between the wires with the lamps in place and the switches open, the switches are the only leakage points that count.

In the example considered in the text the resistance to earth was about 6 megohms, and there were 62 leakage points, hence the average resistance per leakage point was 6×62=372 megohms. Remembering that one switch base of good quality may have a resistance as low as 100 megohms, it is evident that the installation as a whole was in excellent condition as regards insulation.

cloth, and the test piece was therefore baked for about four hours at 150 degrees centigrade. In one hour after removal from the oven the test piece was cold and its resistance was then about 1,300,000 megohms when tested at 500 volts. It was then left exposed to the air of the experimental room in order to find out to what extent micanite cloth acted as an absorbent of atmospheric moisture. At the end of 24 hours' exposure the resistance had fallen, although it was still barely within the range of easy measurement.

It is by no means surprising to find a laminated substance like mica acting as an absorbent body, and in the form which it necessarily takes in micanite cloth there are innumerable capillary spaces available for the formation of leakage paths. It should be noticed that in these curves the ratio R_{50}/R_{500} is much less than 2; the average value deducted from seven curves obtained from micanite cloth test pieces is 1.47.

Many other more or less absorbent insulators might be added, but the three examples which have just been examined are typical of the whole. The composition of the insulating substance seems to be of little importance. So long as the structure of the material is such as to provide capillary spaces to harbor moisture, leakage will take place in the characteristic manner. Of course, the difficulty of maintaining adequate resistance in absorbent insulators is fully realized, and they are seldom used without an attempt being made to exclude moisture by means of some non-absorbent insulator applied as an oil or a varnish and intended to close all the capillary channels. In the following sections the effect of filling up the pores of absorbent materials is dealt with in connection with oiled paper and varnished windings.

Conduction Through Oil.

Oils are good insulators in themselves, but they are capable of absorbing traces of water. An investigation was therefore made to ascertain whether water when absorbed in oil behaved in the same way as moisture in an absorbent solid. For the purpose of the test a glass beaker was fitted up with two flat copper disks, one above the other, to act as electrodes. The upper disk was adjustable up and down by a micrometer screw so that the electrodes could be set accurately to any required distance. Several different kinds of oils and varnishes (and also liquids which are used as solvents in varnishes) were tested in this apparatus and in every case Ohm's law was followed, the resistance proving to be a constant quantity not varying with the potential difference between the electrodes. It was necessary to know whether the same thing applied to oil in which water had been absorbed. The oil used for the test was a heavy hydrocarbon sold as a lubricant for gas-engine cylinders. It had the disadvantage of a rather low resistance—about 2.5 million megohms for a centimeter cube[4]—but it was chosen because a large store of it was available, and hence uniform samples might be relied on. A trace of distilled water was dissolved in the oil by putting a few drops into a bottle containing a pint of oil and stirring for many hours. The oil was then left at rest for about 48 hours in order to allow the suspended water to settle down. The slightest trace of water in suspension is apt to cause instability in the resistance because all the suspended particles are slowly drawn in between the electrodes by the electrostatic force, and when there they tend to form conducting chains from one electrode to the other. The result of a test with oil containing absorbed water is shown in Fig. 6, the upper curve being obtained from cylinder oil freshly drawn from the storage tank and the lower curve from the same oil after absorbing water. Notwithstanding some irregularity due to water in suspension, the effect of the absorbed water is evident in the marked lowering of the resistance. But of any effect like that due to moisture in absorbent solids there is no trace. In both curves the resistance is practically constant, Ohm's law being followed well enough.

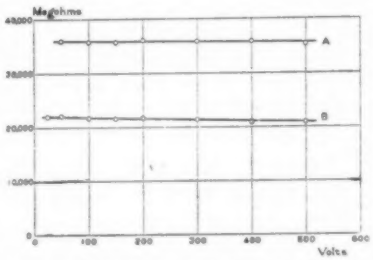


Fig. 6.—Resistance of Cylinder Oil When Dry (A), and With Trace of Water (B).

Oil-Impregnated Paper.

Paper containing moisture may be saturated with an insulating oil without producing any effect on the leakage paths formed by the water. It is evident that the oil does not displace the water, or break up the conducting paths, or interfere in any material way with the characteristic conduction due to the moisture which was present in the paper before the entrance of the oil.

The converse, however, does not hold good. Water will not only find its way into paper which has been dried and soaked in oil, but will so far displace the oil as to form leakage paths. As is well known, paper impregnated with oil easily absorbs water from the air. Hence the necessity for the lead covering and soldered joints of an impregnated-paper cable. To ascertain whether moisture absorbed by an impregnated-paper cable was able to form leakage paths of the same kind as those in other absorbent solid materials, a short piece of lead-covered impregnated-paper cable was left with both ends open and exposed to the air of the experimental room. The curve obtained when the cable had been open to the air for 13 months had nothing to distinguish it from the characteristic curves of more ordinary absorbent insulators. The ratio R_{50}/R_{500} is 1.97, quite a normal value for a moisture curve when the absorbent material is under a moderate compression.

Although water ultimately finds its way into impregnated paper, the process of absorption is extraordinarily slow. The piece of paper cable when first tested had a resistance of about one million megohms at 500 volts, and although this high value was not maintained for more than a month or so, it required nearly 9,000 hours' exposure to the air to reduce the resistance to 33,000 megohms. Had the cable been insulated with dry paper (not impregnated) the resistance would have fallen to the same extent—in other words, the same quantity of water would have been absorbed—in four or five hours at the most.

The experiments on oiled paper lead irresistibly to the conclusion that the mode in which absorbed water forms conducting paths is substantially the same whether the insulator is saturated with oil or not. The water may be in the insulator before impregnation with oil or it may be very closely absorbed afterwards, but once inside it will conduct electricity just as though the oil was not there.

Varnished Windings.

Varnish is intended to prevent water from forming leakage paths. To do this it must either keep out water by closing all the pores at the external surface of the insulator, or it must interpose a solid and impervious layer of the body of the varnish between the conductors and the porous insulator. Applying varnish by a brush aims at the first alternative, vacuum methods aim at the second. It need hardly be pointed out that when a porous body is saturated with a liquid varnish, and the solvent is then dried out, the solid body of the varnish remaining in the insulator is necessarily insufficient in quantity to fill up the pores. They can only be entirely filled up by soaking the insulator in oil, or in a melted wax or in some equivalent solid insulator which can be liquefied by heat. Hence a porous insulator, even when varnished, is likely to have many channels available for the reception of water. Whether water can find its way into them depends on how far the varnish has been able to stop up the pores on the outside of the insulator.

Experiments on varnished windings occupied many months, and in several cases varnished test pieces have been kept under observation for over two years.

4 The oil used for impregnating paper cables has a specific resistance of about 700 million megohms, at 15 degrees centigrade.

Their outcome can be summed up in a sentence. Varnish reduces the extent to which moisture is absorbed, but it seems powerless to stop absorption altogether if the windings are subjected to the temperature variations which occur in ordinary use. This failure to exclude moisture was exhibited in every trial, both by test pieces varnished by a vacuum method and by those which had received coats of varnish applied by a brush.

There can be little doubt that the failure to exclude moisture altogether is due to insufficient elasticity in the body of the varnish. Unless this is a highly elastic substance it is unable to follow the expansions and contractions of the windings, and ultimately the continuity of the coat of varnish is broken up, leaving numerous crevices by which moisture can enter.

The Law of the Moisture Curve.

The experiments on absorbent insulators suggest that underlying the phenomena there is some ascertainable law of conduction by moisture. The fact, which the wary reader will have perceived already, that it has been possible to compare one curve with another without taking potential-*gradient* in the insulator into account, is sufficient proof that the curves have some simple property in common. And so they have; for in every case in which moisture conduction alone controls the resistance curve, it is found that over a considerable length along the curve the ratio $R_v/R_{10\,v}$ is fairly constant whatever may be the value of v in volts. Hence although the insulators have varied widely in thickness, the ratio R_{50}/R_{500} has served quite well as a rough guide for comparing the different curves.

A good example of this property is afforded by the moisture curve for cotton given in Fig. 5. The fact that in this case a line drawn through the plotted observations forms a smooth curve over a very wide range of potential difference is of itself an indication that disturbances were absent, and hence we are justified in looking here, if anywhere, for a simple law.

The law would be expressed empirically by the formula

$$v\,R^x = k$$

In each particular case a value may be chosen for x which will express the law of the individual curve over a great part of its length.

Compound Insulation.

If insulators are divided into two groups according to whether the insulator is composed of absorbent materials alone, or on the other hand built up of some non-absorbent dielectric insulator in series with an absorbent insulator, then their characteristic curves will be found to exhibit a marked difference in curvature, the decrease in resistance being much larger in the first group than in the second. In 47 curves obtained from insulation composed entirely of absorbent materials, such as cotton, paper, cardboard, fiber, and other things, both varnished and unvarnished and including oil-impregnated paper, the average value of the ratio R_{50}/R_{500} was 2.20.

This figure is confirmed by the results of a number of insulation tests on absorbent materials carried out by E. H. Rayner at the National Physical Laboratory. The materials included presspahn, Manila paper, oiled paper, oiled board, oiled linen, Excelsior paper, Excelsior linen, and fiber, some of them being tested both in their ordinary condition and after varnishing. The insulators were tested under a compression of about 5.8 pounds per square inch, and the ratio of $R_v/R_{10\,v}$ might be expected to be about 2.1. But as the resistance of each insulator was tested first at 200 and then at 1,000 volts, the value of $R_v/R_{10\,v}$ may be more closely estimated from the observed value of R_{200}/R_{1000} by an application of the empirical formula. Mr. Rayner gives 17 tests within the range of measurement, and taking the whole of these the average ratio R_v/R_{5v} is 1.71. In arriving at this figure all the readings taken at 200 volts *after* the application of 1,000 volts have been excluded, as in nearly every case they showed a marked hysteresis effect. Now the formula shows that *log* $(R_v/R_{10\,v})$ will be equal to *log* 1.71/*log* 5, and hence we find that in Mr. Rayner's 17 tests the average value of the ratio $R_v/R_{10\,v}$ was 2.15, compared with the author's figure of 2.20 deduced from 47 curves. The figure 2.2 may therefore be regarded as a good average value for the ratio $R_v/R_{10\,v}$ for insulation which is wholly composed of absorbent materials, used under a moderate degree of compression.

But in the case of 12 curves obtained from compound insulation, that is to say insulation in which dielectrics like mica or ebonite were used in series with an absorbent material, the same ratio had an average value of a little less than 1.4. The difference is easily accounted for. The law of moisture conduction in any given absorbent material must be the same, whether there is a dielectric insulator in series with it or not, and assuming the dielectric has a constant resistance the absorbent insulator alone is responsible for the curvature of the resistance line.

It must be remembered that a non-absorbent dielectric in series is not the only cause for a low ratio value. We have already seen how the curve flattens out when there is enough absorbed water to form paths of constant resistance in parallel with those which give a typical moisture curve. But under such circumstances the resistance curve will be so very far below the average level which it occupies under more normal conditions that there is no likelihood of the low ratio that is associated with wet insulation being attributed to the presence of a non-absorbent dielectric in series with the absorbent materials.

The percentage degree of absorption at which leakage paths of constant resistance begin to form inside a porous insulator must naturally vary widely in different cases. Judging from the shape of the curves obtained from paper it would appear that so long as the absorbed water does not exceed the amount which is naturally absorbed from the air, leakage through paths of variable resistance is paramount and the normal moisture curve will be obtained. How far paper is typical of absorbent insulators in general remains to be seen.

Electric Endosmose in a Model Insulator.

So far the investigation had not suggested any rational explanation of the moisture curve; possibly because the importance of the principle just referred to was not recognized until after the model insulator, which is now to be described, had given a visible demonstration of the cause of the gradual decrease in resistance with increasing potential difference. The explanation given in the following pages was ultimately arrived at, not as the result of previous experiment, but by first considering what was likely to happen when atmospheric moisture condensed inside a porous insulator, and then putting the notion to the test of experiment.

When condensation takes place on the surface of a solid body it first makes its appearance to us in small detached drops clinging to every roughness, every scratch on the surface. If we suppose the solid body to be an insulator of infinite (or at all events immeasurable) resistance, the presence of detached drops of water will not make any appreciable change in that resistance, and the same holds good for the maze of internal surfaces inside a porous insulator when moisture condenses there. But, as we have seen, the absorption of a mere trace of water brings about a vast decrease in resistance; reduces it from an immeasurable value to one easily within the range of our instruments. We cannot suppose the drops to coalesce in order to form a continuous leakage path, because in that case conduction would be simply that of an electrolyte and would follow Ohm's law, leaving the moisture curve unexplained. We must therefore look for connecting links between the drops to establish a complete conducting chain. It would be natural to suppose the links to be films of some kind condensed on the surfaces of the capillary passages in the insulator, and to account for the characteristic curve the films would have to be endowed with a property analogous to that of the electric arc; with increasing electric pressure they must increase their sectional area either by reason of the leakage current they carry, or in consequence of some effect which, like

endosmose, depends on the potential-gradient. At the time this hypothesis was first outlined it hardly appeared any more likely to contain the germ of truth than half a dozen others that had suggested themselves in the course of research, only to break down on trial. Nevertheless it was put to the test of experiment, and has proved itself capable of accounting for the facts.

To experiment with a series of drops and connecting films deposited on any kind of exposed surface would have led to almost certain failure, owing to the difficulty of protecting the films against currents of air. This liability is almost non-existent inside a porous insulator, where any considerable change in the humidity of the air occupies a comparatively long time, and the consequent changes in the films and their resistance are not too quick for experiment. To imitate this condition of moderate stability it was decided to construct a model insulator by drawing a series of drops of water and bubbles of air into a capillary glass tube, so that each bubble should constitute an enclosed region within which a film could form on the internal surface of the tube and remain there entirely undisturbed by air currents. Glass was not only an obviously convenient insulating material for the purpose, but as it was intended to look for some visible effect of endosmose a transparent tube was essential.

The glass tube, which was about a couple of inches in length, with a bore of 12 or 14 mils, had its ends bent downwards so as to dip into water contained in two small beakers. Before placing the tube in position it was completely filled with a succession of drops of water separated by bubbles of air, the bubbles having an average length equal to four or five times the bore of the tube. Two copper wires, one in each beaker, served as the electrodes. The complete arrangement, as shown in Fig. 7, was fixed under a microscope in such a position that portions of two adjacent drops, with the whole of the air bubble in between them, came within the field of view, as indicated in the upper part of the same figure. At A and B dark transverse lines, corresponding to "Newton's rings," were seen at the end of each drop where the water-air surface approaches the glass at a capillary angle. These lines formed convenient gauges for estimating the initial thickness of the film of water deposited on the glass, and it was apparent that in the neighborhood of the capillary edges of the drops the thickness of the film did not exceed one-quarter of the mean wave-length of light.

To understand the behavior of this tube it is necessary to have the principle of electric endosmose clearly in mind, and as this effect is almost inseparable from electricity and water a short account of it may not be out of place in a paper which is so largely concerned with the passage of a leakage current through moisture.

When an electrically charged body is placed in an electric field it is attracted one way or the other according to whether the charge it holds is positive or negative, the attractive force being proportional to the potential-gradient (volts per centimeter). It does not matter what the attracted body is made of; water will do as well as anything else, and, given the proper conditions as regards voltage-gradient, and so on, it will move. For instance, water which is lying on an insulator in an electric field will be urged towards the negative side of the field and will flow in that direction if it is free to do so. A little scrap of paper jumping up from the table towards an electrified stick of sealing-wax is a more familiar example of the same action. The electrification of the sealing-wax provides the potential-gradient, and the scrap of paper moves upwards if the gradient is steep enough. Both the scrap of paper and the water move for the same reason, and the only difference lies in the mode by which they receive the necessary charge of electricity. In the case of the scrap of paper the charge is induced by the sealing-wax; whereas the water becomes charged by *contact* with the insulator, just as zinc becomes charged by contact with copper. But although no real difference in principle is involved the action goes by very different names in the two cases. When the scrap of paper jumps we are content to say that it does so because it is attracted, whereas when the water moves because it is similarly attracted the action is called endosmose.

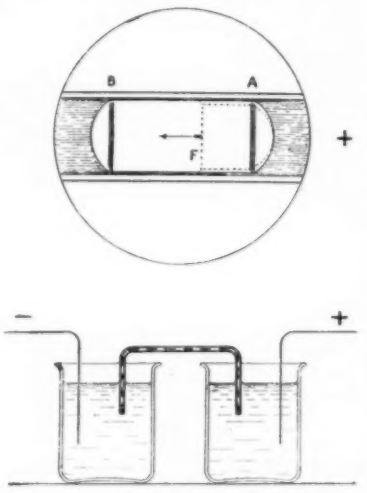


Fig. 7.—Elementary Model of an Absorbent Insulator.
The upper figure represents an air bubble as seen through a microscope.

Any liquid would exhibit the phenomena of electric endosmose provided two essential conditions were fulfilled. These are that the liquid must be either electro-positive or negative to the channel which contains it, otherwise there will be no charge and no force; and its specific resistance must be very high, otherwise it will be impossible to maintain a steep potential-gradient inside the liquid without overheating by excessive current. Let an attempt be made to propel mercury by endosmose, and a gradient of something like 50 volts per centimeter would be required to overcome friction. But by the time the gradient had reached 2 or 3 volts per centimeter the resulting current flowing in the mercury would have raised it to boiling-point and the experiment could not go on.

Water, and especially pure distilled (or condensed) water, happens to possess both the essential properties in a remarkable degree. It is strongly electro-positive to all insulators (with the one doubtful exception of hair); and its resistance is from 20 million to 2,000 million times greater than that of mercury, so that it is possible to maintain a potential-gradient of several hundred volts per centimeter without any overheating by electric current.

Endosmose may be made visible in a short glass tube connecting two water vessels. By contact with the glass the water in the tube acquires a positive charge which occupies a cylindrical layer of water next the wall of the tube, being held there by the corresponding negative charge in the glass surface. When a potential difference of several hundred volts is maintained between the water vessels, the charged water in the tube is strongly attracted towards the negative vessel and moves in that direction down the potential-gradient. This movement is confined to the charged layer and such water as it can drag along with it, and when the bore does not much exceed half a millimeter the whole of the water will be set in motion and may be seen traveling slowly towards the negative end of the tube.

Endosmose has been chiefly studied as it appears in glass tubes and in the capillary passages inside porous materials; hence the name, which may be clumsily translated "within-propulsion." But the name must not mislead us. It is not essential to have the water *within* anything; all that is necessary is that the water should be lying in contact with an insulator and forming a conducting path between two electrodes. Then, if the voltage-gradient between the electrodes is steep enough, and the water is free to move, it will find its way towards the negative electrode whether there is any definite channel for it to run in or not. But without some kind of trough or tube the water is apt to go by all sorts of devious ways towards its goal, and the confused motion becomes difficult to follow by eye.

To return to the experimental tube with its chain of drops and films. On applying an electromotive force to the electrodes in the two beakers the effect of

electric propulsion or endosmose was at once apparent. On closing the circuit the surfaces of the two drops visible in the field of the microscope instantly changed their curvature, the positive surface *A* pushing its edge out towards the negative side of the field of view, and the negative surface *B* decreasing its curvative by withdrawing its edge inwards. The dotted lines in Fig. 7 indicate the general nature of this effect, but grossly exaggerate the extent of the change. If the film connecting the two drops happens to be visible every part of it is seen to experience a sudden force pushing it towards the negative side. The effect of the hydraulic pressure produced in the drops by the electric propulsion is seen at the same time; a stream of water is forced out from the edge of the positive drop and flows rapidly towards the negative drop, increasing the thickness of the film as it goes along. The advancing wave front (*F* in Fig. 7) of the traveling water is clearly visible, and if the potential difference is gradually increased, the growing thickness of the now moving film is made apparent by its assuming, one after another, the colors characteristic of thin films.

The sectional area of the films is of course exceedingly small compared with that of the drops and hence the resistance of a complete tube of given diameter is determined almost entirely by the aggregate length and mean thickness of the films, the resistance of the drops being negligible by comparison. The visible increase in the thickness of the film will therefore be made evident also by a concurrent fall in the resistance of the tube, and if a series of tests be made at gradually increasing potential differences the characteristic curve of the tube as an absorbent insulator may be drawn. In Fig. 8 a curve of this kind has been plotted from tests made on a glass tube about 1.5 inches long and 13.5 mils bore, containing water separated by 12 bubbles of air, each of which provided a film length of about 70 mils. The early part of the curve is smooth enough, but the current became increasingly unsteady as the voltage was increased and accurate observation was impossible at the higher readings.

When the electromotive force is cut off, the surfaces of the drops are instantaneously restored to their normal shape. The surplus water in the films then withdraws very slowly into the adjacent drops, until, after a period which may be hours rather than minutes, the films are reduced to their initial thickness and the resistance of the tube recovers its initial value. The extreme slowness both of the initial formation of the films and their recovery after the application of any considerable potential difference, was not fully realized until the results of all the tests made on tubes were collated some time after the conclusion of the experiments. It then became apparent that the majority of the tests made with single tubes had been carried out before the films had settled down into a normal condition, and their instability naturally led to large discrepancies, particularly at the higher voltages.

But a single tube, one capillary channel, could hardly be expected to give a faithful imitation of a real insulator. Much better results have been obtained from models composed of a number of similar tubes connected in parallel, particularly when they have been given ample time to settle down into a normal condition.

Reckoning from the average of four curves the ratio R_{50}/R_{500} is 2.1, a figure which agrees surprisingly well with the average ratio 2.2 obtained from absorbent insulators.

Hysteresis, which is such a marked feature of the moisture curves of real insulators, is equally characteristic of the model. In each series of tests upon the model the return curve obtained by retracing the voltage steps from 500 back to 25 volts has indicated a pronounced hysteresis effect.

The general resemblance of the curves given by glass models to those which are

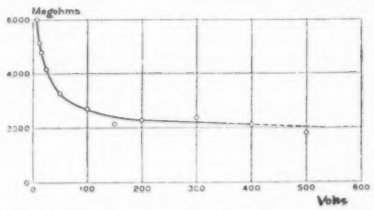


Fig. 8.—Resistance Curve for Capillary Tube of Fig. 7.

characteristic of absorbent insulators is evident. In the decreasing resistance with increasing voltage, in the extent of the decrease, in the slow recovery or hysteresis, even in instability, the films and drops possess properties which are common to every absorbent insulator.

But in one matter a simple model composed entirely of open tubes differs fundamentally from a porous insulator. The first effect of heating an absorbent insulator is to bring about a very large decrease in resistance. Heat this too simple model, and the expanding air bubbles lengthen the films and increase the resistance.

But, after all, the structure of the model is not much like the real thing. For the tangled maze of interconnected channels in a porous insulator the model substitutes a number of parallel channels, each going without a break from one electrode to the other; it contains no blind alleys and no cross-connections.

The net resistance of a measured length of film in a glass tube containing drops of water of known conductivity enables the thickness of film to be estimated, on the assumption that it is uniform. Reckoned in this way the films in the tube which gave the curve shown in Fig. 8 had a thickness not exceeding 0.00001 inch. The films are of course very far from being uniform in thickness and hence this figure is necessarily an overestimate.

One of the films in the same tube was measured by the method of Newton's rings, which gave the value 0.0000055 inch.

The two measurements were made at the same time, the films having the maximum thickness corresponding to a potential difference of 500 volts. The two values do not differ more than one would expect, and as the second method is the more accurate we may say that in this tube the thickness of the films was about 0.000006 inch when swollen by the action of endosmose. Hence judging by the concurrent decrease of resistance, their initial thickness must have been about 0.000002 inch. This is so much less than one-quarter of a wave-length of light that in the initial state the film had no perceptible color by which to estimate thickness.

Another remarkable property of absorbent insulation finds a ready explanation in the model with its tubes full of drops and films. Over and over again in the course of the investigation a number of moisture curves have been obtained under widely different conditions as regards the quantity of absorbed water. Yet the curvature of the characteristic has remained practically unchanged throughout the whole series of tests notwithstanding the enormous changes in the general level of resistance which accompany changes in the amount of absorbed moisture. This permanence in the shape of the curve has already been referred to, and in view of what has been demonstrated by means of a bundle of capillary glass tubes the explanation is clear. Place a damp insulator in a dry atmosphere so that evaporation takes place. Evidently the more accessible films will evaporate first, followed by film after film, and the least accessible and thickest films will be the last to go. But as each film gives more or less the same sort of curve, the curve from a few dozen film channels in parallel would be indistinguishable in shape from the curve obtained when there were hundreds or thousands of films acting as parallel leakage paths. Hence so long as a few film channels are left intact—just enough to carry a measurable leakage current—the resistance-voltage curve will retain its characteristic shape. We now realize why it was that a piece of impregnated-paper cable which had absorbed a trace of water, giving a resistance of several hundred thousand megohms, had a characteristic curve of the same shape as that obtained from a dynamo armature the resistance of which was less than a dozen megohms. The curve is characteristic of the film with its adjacent reser-

voirs of dormant water; the magnitude of the conductance is simply a question of the number of film paths acting in parallel.

The marvelous rapidity with which the resistance alters when a change occurs in the humidity of the air is of course attributable to the extreme tenuity of the films.

Summary and Conclusion.

The true dielectric resistance of insulation is enormous compared with the actual insulation resistance obtained in practice, and in all ordinary cases we need only consider the leakage which takes place through films of moisture condensed on the external and internal surfaces of the insulating material. Dielectric leakage is insignificant and may be left out of account.

The quantity of water in the conducting films of moisture is not only very small, but it forms an exceedingly small proportion of the whole volume of absorbed water.

Impregnating an absorbent insulator with oil or varnish delays the absorption of water and no doubt limits the amount absorbed, but it does not prevent the ultimate formation of the moisture films which constitute leakage paths.

Conduction through absorbent insulation does not follow Ohm's law. The relation between the resistance of an absorbent insulator and the potential difference which is applied to it is expressed by a curve which is characteristic of conduction by films and drops.

When the absorbed water exceeds the amount which the material can hold in the form of dormant water and leakage films it begins to form conducting paths of constant resistance. Hence the moisture curve gradually decreases in curvature as absorption goes on, and ultimately when the resistance has fallen to a very low value the curve is reduced to a horizontal straight line, indicating conduction by Ohm's law.

In compound insulation consisting of an insulator in which conduction follows Ohm's law, in series with an absorbent material which follows the law of moisture conduction, the resultant curve has less than the normal curvature.

The degree of curvature in the characteristic curve of compound insulation enables the resistances of the two components to be separately estimated.

In compound insulation a curve of normal curvature indicates failure of the dielectric component. A straight horizontal "curve" (Ohm's law) indicates failure of the absorbent component.

Finally, the broad principle of film conduction in an absorbent insulator is clear; the moisture curve—the first part of the complete characteristic curve—is the direct result of electric endosmose. The electrically produced hydraulic pressure drives dormant water into the films, and their increasing thickness is made evident by the gradual fall in resistance as the potential difference is increased.

At what point leakage through moisture becomes dangerous; whether the ultimate effect of prolonged endosmosis is to safeguard the insulation by driving all the water away from the positive conductor in a direct-current system, and from both conductors if the supply is by alternating current; whether it is possible to predict the breakdown voltage—these and other questions can only be answered by an investigation of the second part of the characteristic curve. Preparations for this are not yet complete, and so far it has only been possible to extend the curve to the breakdown point in one or two simple cases for which the voltage already available proved sufficient. In these examples the curve began to bend downwards at pressures well below the breakdown value, thus indicating the impending failure without exposing the insulation to the risk of permanent injury. It remains to be seen whether this useful effect is general, or whether, as seems more probable, it is confined to insulating materials in which failure begins along already existing leakage channels. It is a significant fact that in the model insulator breakdown begins in the form of sparking along the films from one drop to another. Questions of this kind go to the very root of the matter. It is customary to account for breakdown by dielectric stress; a blackened hole appears in the insulation and the inference is too hastily drawn that the puncture process was instantaneous and could not have been foreseen by any kind of test. But nothing in nature, not even an explosion, takes place instantaneously, and the breakdown of an insulator is only sudden to the mind that does not apprehend it.

Electric Furnaces for Steel Refining.

In an address before the Pittsburgh Foundrymen's Association in Engineer's Hall, on December 8, Ernest P. Humbert, of Niagara Falls, N. Y., formerly principal assistant to Dr. Heroult, inventor of the Heroult electric furnace for steel refining, emphasized the superiority of the electric over the open-hearth or non-oxidizing furnace. The subject of Dr. Humbert's address was "The Electric Steel Refining Furnace in the Foundry." He said the demand of steel manufacturers for ferro-chromium of low carbon led Dr. Heroult and himself to invent the furnace which has been adopted by the United States Steel Corporation.

ELECTRIC STRENGTH OF INSULATING MATERIALS.

Monthly Meeting of the American Institute of Electrical Engineers.

The 288th meeting of the American Institute of Electrical Engineers was held at the Engineering Societies Building, New York City, on the evening of December 12. The meeting was called to order at 8:40 p. m. by President C. O. Mailloux, and a paper was presented by F. M. Farmer entitled, "The Dielectric Strength of Thin Insulating Materials."

Dielectric Strength of Thin Insulating Materials.

Mr. Farmer's paper gives the results of a series of tests made at the Electrical Testing Laboratories, New York City, to determine the effect of electrode area on the apparent dielectric strength of thin insulating sheets. There are as yet no standard specifications for testing such materials and there is great divergence as to the size of the electrodes between which the sample is placed in the test. Some contend that a large electrode area more readily gives the minimum dielectric strength and that very small electrodes produce an abnormal concentration of dielectric stress.

Each of the tests was made with two similar, flat, circular electrodes ranging in diameter from 0.039 to 38 centimeters and placed directly opposite each other. The materials tested were varnished cambric and thin sheet hard rubber in relatively dry air and moist air; varnished cambric in dry and wet oil; transformer oil with various spacings; air as a dielectric. No attempt was made to get refined quantitative results, but rather qualitative results. So many variables enter in work of this kind that a high degree of reliability can not be expected. Although the results given in the paper are averages of a great many determinations, considerable allowance must be made in drawing final conclusions. A great deal more work is necessary, such as an investigation of other classes of insulators, effect with electrodes of various forms, effect of other surrounding media, including solids, etc. However, so far as the original purpose of the tests was concerned, the following conclusions were drawn from the results.

The apparent dielectric strength of insulating materials in thin sheet form is materially higher with small electrodes than with large ones. This probably applies generally to all dielectrics, gaseous, liquid and solid, although the amount of the variation differs widely with different materials. The variation with ordinary sheet insulating materials, such as paper and cloth, may be 40 or 50 per cent between one-sixty-fourth inch and 8 or 10 inches diameter, while with oil under the same conditions the variation is over 1,000 per cent.

The prevalent opinion is that the electrostatic stress is concentrated when the dielectric is between sharp points and that failure will occur at a low value. This appears to be the case when the points are very sharp, such as needle points, but as soon as

they have an appreciable area, the puncture value is much higher than with large electrodes.

These tests emphasize a need which has been frequently pointed out, viz., standard specifications for the testing of insulating materials, especially when in the form of thin sheets. It does not seem probable that the dielectric strength of an insulating material under all working conditions can ever be predicted with exactness, but we at least can have standard methods of rating such materials so that a value for the dielectric strength will have the same significance to the manufacturer, the purchaser and the designing engineer.

The discussion was opened by F. W. Peek, Jr., who pointed out the analogy between the magnetic circuit and the dielectric circuit. In designing, the magnetic path is very carefully considered and the magnetic flux-density calculated and it is desirable to consider the dielectric circuit in the same way; indeed it is more important because insulation breaks down not because of a certain applied voltage, but because the electric flux-density exceeds a definite value. In testing for electric strength, electrodes of some simple geometrical form should be used so that the electric flux-density may be determined. Breakdown depends upon the gradient at the point where the flux-density is a maximum. He pointed out the difference between gaseous, liquid and solid insulators. Air apparently has different strength with electrodes of different size. For example, with cylindrical electrodes the strength is apparently greater for small wires than for large wires. He attributed this to the energy necessary to rupture the insulation. Thin films of air with spherical electrodes have been subjected to as much as 250,000 volts per centimeter and thin films of oil as high as 1,000,000 volts per centimeter. Pure oil acts very similarly to air, but with solid insulators homogeneity is lacking, so that the results obtained from tests will depend upon the size of the specimen used, breakdown occurring at the weakest point. While air will hold indefinitely a voltage within two per cent of breakdown, the loss which takes place in solid insulation heats and weakens it so that after a time it ruptures at a lower voltage than would be required for instantaneous rupture. For commercial testing, a standard form for electrodes should be adopted, the shape being such that the stress on the insulation can be calculated.

C. E. Skinner read some written discussion which had been prepared by Phillips Thomas and by R. P. Jackson. Mr. Thomas considered that the minimum strength due to the weakest spot would nearly always be reached below a diameter of 15 inches. In testing condensers for breakdown he had found it necessary to parallel the tested condenser with one of larger capacity, so that the distortion and regulation will not be affected by the test piece. It is also necessary to measure breakdown voltage directly at the electrodes. The voltage readings described in the paper would not give any information regarding distortion, which might be different for each area and thickness tested.

Mr. Jackson considered the lowest values obtained by Mr. Farmer, namely, those obtained with electrodes of large area, as the desirable values to use in practice, since this most nearly approaches the conditions of actual use. He pointed out that the size of the electrode affected the capacity of the test circuit and that a small transformer then might affect the results. He described experiments in which electrodes of tinfoil and of pieces of brass had given different results. This might be due to the brass conducting away the heat generated in the dielectric and thus keeping the temperature down better than the tinfoil. Puncture tests of short duration are of little value in furnishing data for use of insulation, and ultimate breakdown values after long application are the values desired.

Mr. Skinner then spoke of his own work in this subject, which had been pursued for the last 14 years. Insulation is the important item in limiting the capacity and life of electrical machinery, a fact which is now generally recognized. There should be definite specifications for testing insulating materials and the American Society for Testing Materials has a committee at work on this subject. The American Institute should co-operate with this committee. He considered the instantaneous breakdown strength of little value in design work. The results in Mr. Farmer's paper might be modified by changes in the testing transformer, the pressure applied and the method of applying the voltage. He referred to the work done by Mr. Rayner at the National Physical Laboratory in England, in which the dielectric losses had been measured and formed a criterion for prophesying the breakdown of the insulation. Study should be given to the question of power-factor and dielectric losses and the endurance of the insulation under continued stress.

Henry W. Fisher told of his work in testing insulating material, especially the varnished cloth used in cables. He gave a method for testing large areas of this material and a more practical apparatus consisting of two strips of brass with rounded edges between which the cloth is clamped. The power-factor was found to vary in different material from 20 per cent down to 4 per cent. Curves were shown, giving the effect of varying size of the electrode and of the voltage. Short lengths of cables will stand very much higher voltages than can be applied to long lengths. The old Underwriters' rule was to apply 3,000 volts per mil on a one-foot sample. Any kind of rubber would stand this test, but a coil or a long cable would break down much more readily.

M. E. Tressler had experimented with yellow varnished cloth and obtained curves of the same shape as Mr. Farmer. Electrodes of sizes from 1 to 100 millimeters in diameter were used, with square edges. Most of the change with size of electrode took place below 20 millimeters, so that nearly constant results would be obtained with electrodes exceeding 25 millimeters in diameter, with thin material. With greater thickness of insulation the variation with size of electrodes decreases and above 240 mils there is very little effect. These tests, like Mr. Farmer's, were carried out by steadily increasing the voltage to breakdown so that the insulation does not have time to be affected by the heat. A much better indication of strength under working conditions would be obtained by using 50 per cent of the instantaneous disruptive voltage for one minute and increasing by steps of 10 per cent for one minute each until breakdown occurs. This test will give lower disruptive voltages than the instantaneous test. The effect of size of electrodes is much less with this form of test. He recommended the following specifications: (1) One-hour tests where possible, the one-minute puncture voltage being used to indicate the starting voltage for the hour test. (2) Flat disk electrodes 10 centimeters in diameter with practically square edges and insulated on the sides to prevent corona and arcing; for testing solid insulations. Flat disk electrodes 25 millimeters in diameter with edges rounded to one millimeter radius and spaced with faces parallel and 2.5 millimeters apart; for testing liquid insulations. (3) All tests of solid insulation should be made under oil when possible, and a pressure of 100 grams per square centimeter applied by the terminal to the insulation. (4) Two temperatures of test should be considered standard; one at 25 degrees centigrade and the other at the highest "hot-spot" temperature allowed on the given insulation to be tested. (5) The insulation for test should be 2.5 millimeters thick, or as near thereto as possible.

A good indication of the value of insulation for high or moderate voltage would be to measure the thermal conductivity at different temperatures and the energy loss at various voltages

and temperatures. If the insulation has a large energy loss and low conductivity it would not be much good at high voltages, but if the energy loss was small and the conductivity high, its dielectric properties would be good.

E. B. Rosa emphasized the advantage of standard methods for making such tests and the desirability of making energy measurements in addition to the breakdown measurements. The measurement of the power-factor of the current supplied to a dielectric shows great differences. The angle corresponding to the power-factor may be as small as one minute for a material like mica, whereas in other materials it may become as much as 20 degrees. The heating effect consequently has a range of about 1,000 to 1, and this will affect the electric strength. He referred to the work of Dr. Kinzbrunner at the Technological School at Manchester, who had found the electric strength to vary with pressure. He recommended a value of 500 grams per square centimeter as a standard test. Four centimeters was a suitable diameter for electrodes. His results differed from those of Mr. Farmer.

Clayton H. Sharp said that further researches of this character should be made and advocated the adoption of standard specifications for testing.

John B. Taylor said there were three factors which might account for apparent decreasing strength as the size of the electrode surface is increased: (1) If the transformer is small the increase in capacity would tend to raise the voltage applied to the specimen without raising it by the same amount on the low-tension voltmeter. (2) With a larger sample the probability of covering a weak spot is increased. (3) A large sample presents less opportunity for the loss of heat. Since all three of these factors work in the same direction a combination of them might easily account for the results obtained. In the results given heat could not have much effect on account of the rapidity with which the test is made. He suggested the use of direct current in breakdown tests, as this would eliminate some of the uncertain factors, such as heating, capacity and voltage ratio.

A. E. Kennelly pointed out that the dielectric was really not a homogeneous material and in the case of varnished cambric there were really three different materials involved—air, varnish and cambric—and the relative thicknesses might be different in different places, thus altering the potential-gradient with flat specimens such as used in the test. It is not likely that the electric flux-density would vary appreciably with the diameter of electrodes. The results could hardly be accounted for by the greater probability of weak spots for a large specimen since the range of results was no greater with the large specimen. The problem, however, is a very complex one and he favored standardization of tests for practical purposes. Large test areas involved greater expense and it was desirable when carrying out a large number of experiments to make use of small samples.

D. B. Rushmore pointed out the necessity of getting down to the underlying principles which determined the breakdown of dielectrics.

H. M. Hobart spoke of the relation between the aging of insulating material and the temperature to which it is subjected and the need of experiments to establish this relation. Experience with apparatus in service has indicated about what can be expected up to 100 degrees centigrade, but manufacturers now want to consider what will take place at temperatures up to 200 degrees. He spoke of the differences arising from the shape of electrodes in actual machinery and thought the usual methods of testing magnified these difficulties. He spoke of the folly of flash tests at high voltages and the possibilities of jeopardizing the subsequent life of the machine by such a test. The machine may survive the test but it is never known what damage has been done. He did not think tests should be made with the apparatus in parallel with a spark gap.

W. I. Middleton referred to tests which he had made upon varnished cambric cloth, his experience having been similar to that of Mr. Farmer. The average difference between small and large electrodes is about 50 per cent and the cause of it had never been explained. He had observed the same results as Mr. Fisher with reference to long and short lengths of cables. The results obtained could not be explained very well on the basis of the distortion of the wave nor on the greater probability of weak spots with a large electrode, since similar results were obtained with oil as with solid dielectrics. While oil is the best insulating material known, it gives results which vary more than in any other material in use. He advocated a standard size of electrode and an instantaneous breakdown test, as this eliminated the heating effect.

C. F. Scott pointed out the necessity of determining the fundamental physical laws at the basis of the phenomena under consideration and their mathematical formulation.

Mr. Farmer then closed the discussion. He considered the hypothesis of weak points in the insulation untenable, since the same general curve was obtained in all of the tests, including oil. Heating could not enter into the results since the tests covered only a few seconds each, and distortion was not likely to have taken place as a 10-kilowatt transformer was used. To determine the electric strength of the material in service the temperature element must be taken into consideration, as well as other conditions, such as pressure. Specifications should be drawn with a view of enabling tests to be made quickly and cheaply on small samples and so that everybody will understand what they mean. Then each individual can apply a factor of safety to suit his own conditions. In answer to a question he stated that the punctures were no more numerous around the edges of the electrodes than elsewhere. This was to be expected, since the edges of the electrode were rounded.

Electrically Operated Aerial Cableway Over Andes Mountains in Colombia.

Work is about to begin on the construction of an electrically operated cableway to be 37.5 miles long and to cross the eastern range of the Andes Mountains at an elevation of 11,000 feet above sea level in Colombia, South America. The cableway is to connect the cities of Mariquita and Manizores, and will really be an extension of the La Dorada Railway & Rope-Way Extension Company's railroad from Ladorada to Mariquita. This extension could be built in no other way because of the ruggedness of the country it is to cross.

The steel cables are to be supported on a series of steel towers varying from 40 to 125 feet in height; these will be set in solid rock or concrete foundations. The cableway will be in 12 sections and at each junction point between sections there will be an electric motor of sufficient power to drive both sections. A hydroelectric plant will be built at a point three miles south of Mariquita. It will contain two water-wheel generator units capable of supplying the entire line. Water will be brought from the Andes Mountains through two steel flumes. Machinery for the power house and line, as well as the steel cables, will be furnished by English firms. The structural steel for the towers and braces is being made in the United States. Preparation of plans, engineering work, contracting work, etc., is in the hands of Sir Douglas Fox, London, England. The entire project is to be completed by January 1, 1915.

American electric incandescent lamps are being installed for street lighting in Hyderabad, India.

BOOK REVIEWS.

"Single-Phase Commutator Motors." By F. Creedy. New York: D. Van Nostrand Company. Cloth, 113 pages (5½ x 8½ inches), illustrated. Supplied by the Electrical Review Publishing Company for $2.00.

It is no easy task to criticise a book in which the author treats a familiar subject from a new point of view; we become imbued with the conventional aspects and treatments of certain types of engineering problems, and the effort required to read the work of an original writer with something fresh to say, is frequently underestimated by the author himself. Mr. Creedy has developed a method of alternating-current analysis which is obviously the result of much thought and conscientious work. His aim is commendable, since he strives to put the usual more or less involved, and even vague, conceptions regarding the action of the single-phase motor into a new form, less remote from the physical conception of what occurs in the machine than the methods followed by some mathematical treatises. As these remarks might give the impression that the author's treatment of the subject is non-mathematical, it may be stated that this is not the case. The treatment is accurate, and the subject is looked at from a mathematical viewpoint, but the introduction of higher mathematics has been avoided.

The different types of single-phase commutator motors are reviewed, and their characteristics explained; but the main object of the book is undoubtedly to expound the principles of the author's method of presentation, based on the recognition of the elliptical field distribution, and a knowledge of the properties of the ellipse. The treatment is not difficult, but the book requires the earnest and close attention of the reader if he is to derive much benefit from it. The degree of application and of concentration required of the reader is perhaps greater than the author may deem necessary, and it is possible that he might have given more space to the introductory portions of the book had he endowed the imaginary reader with but moderate intellectual qualities, and a disinclination—not uncommon in these days—to assimilate new ideas and master new methods, unless presented in an attractive form requiring little mental effort in the preliminary stages of the subject.

In his preface, the author states that the book is written for two classes of readers: (1) the professional man interested in the type of machine dealt with, and (2) the advanced technical student, and teacher. He states further that the success or otherwise of his attempt to present a simple and readily applicable theory must be left to the decision of the reader. The present-day reader will undoubtedly decide whether or not the book supplies an immediate need; but the element of time appears to be necessary to the proper evaluation of all pioneer work. The present instance can perhaps not properly be compared with the situation when Mr. L. B. Atkinson read his classic paper on the alternating-current motor before the Institution of Civil Engineers nearly sixteeen yars ago,[1] because Mr. Atkinson was without doubt "ahead of his time," and Mr. Creedy may have produced his book at an opportune time; but on the other hand, if its reception should not be favorable, that would not necessarily be a true indication of its ultimate value.

Minor criticisms would be out of place in reviewing a book of this nature; but the author appears to be fully aware of possible shortcomings, and leaves it to other writers to build upon the foundation he has laid. He deserves the thanks of all those who can appreciate an earnest effort towards simplification and a return to fundamental principles in a subject which abstract mathematical methods are liable to carry beyond the field of our physical conceptions.

A. STILL.

"The Lighting Book." By F. Laurent Godinez. New York: McBride Nast & Company. 109 pages (6 x 9 inches), illustrated. Supplied by the Electrical Review Publishing Company for $1.25.

No review of this valuable little book can do it justice because it deals with a subject which people in general do not know exists. We take it up with a sense of curiosity and lay it down, after reading every word, with a feeling that we have been admitted to a new view of the possibilities which surround us and hitherto have been almost wholly ignored.

Mr. Godinez approaches the theme of illumination with a theoretical and practical knowledge which engages the respect of the reader from the first page to the last; and the author's sympathetic enthusiasm carries one along in a growing purpose to benefit by the information and suggestions which are imparted in every paragraph. He neglects nothing which will tend to clarify his meaning, yet without any recourse to technical expressions or mathematical formulas.

"The Lighting Book" is intelligible and necessary alike to the woman who wishes to arrange her house-lighting effectively; to the man who wishes to get the best results in a store or office; and to the contractor, or manufacturer of lighting appliances, who is anxious to make a reputation for originality. It is a most successful attempt to treat a complicated question in a simple manner.

Finally, whether it be a matter of gas or of electricity, its suggestions are quite as practicable to people of moderate means as to the very rich.

G. H. PAINE.

"The Electrical Blue Book—1913-14." Sixth edition. Chicago: Electrical Review Publishing Company. Cloth, 228 pages (9x12 inches), illustrated. Supplied by publishers for $2.00.

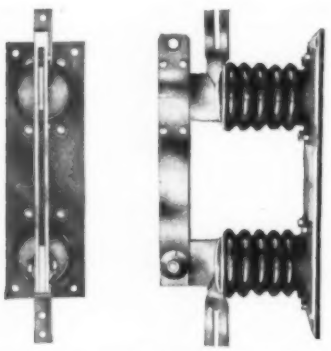
Buyers and users of electrical material require authoritative information with respect to the interpretation of the National Electrical Code, and a description and illustration of the materials which have been approved with regard to the requirements of safety. This volume supplies the desired information. The aim of the publisher is to provide in compact form complete information respecting the Code, the list of approved fittings as published by the Board of Fire Underwriters, and a visualization of the products of the leading manufacturers of electrical material which have passed the tests recommended by the National Fire Protection Association as conducted by the Underwriters' Laboratories. The Code is illustrated and explained so that whether a man be expert or not he can readily understand and interpret the rules as they apply to actual installations. The list of approved fittings gives him the entire range of material which may be installed in conformity with the requirements of the National Board of Fire Underwriters. The illustrated catalog section gives him complete information and a picture of the apparatus as prepared for the market by the manufacturer. An alphabetical list of material and a classified index of advertisers makes the discovery of material for any requirement a matter of instant reference. The list of approved fittings is arranged alphabetically both with respect to the classification of material and the manufacturers of each material listed. Additional features in the sixth edition are chapters on the following subjects: "Common-Sense Methods of Wiring Calculations for Direct-Current and Alternating-Current Circuits;" "Treatment for Electric Shock;" "Street-Lighting Schedule;" "American Institute of Electrical Engineers' Code of Ethics;" "Industrial Motor Applications;" "Care and Handling of Motors;" "Illumination Calculations;" "Chart for Graphic Analysis of the Two-Rate Power Schedule for Central Stations."

1 *Proceedings of the Institution of Civil Engineers*, Vol. 133, p. 113.

New Electrical and Mechanical Appliances

High-Tension Disconnecting Switches of New Design.

A line of high-tension disconnecting switches has been placed on the market by the Electrical Engineers Equipment Company, 12 North Desplaines Street, Chicago, Ill. These are of an entirely new design. The usual pair of clips is supplanted by a solid copper tongue which is cast integral with the switch terminal. Each of the switches is provided with double blades between which the tongue fits snugly. The blades are separated sufficiently to allow of closing firmly over the tongue one on each side. One of each pair of blades is made of the floating type, so as to be self-adjusting by means of a pressure exerted upon it by spring washers that are provided with a take-up device on each blade. These take-ups are arranged to compensate



Figs. 1 and 2.—1,000-Ampere, 13,200-Volt Disconnecting Switch.

for wear both on the tongue and the blades.

The unsightly clamps usually employed for securing the switch ends to the porcelain support are eliminated in these switches by means of a novel method of rigidly anchoring them to the porcelain; this device has been patented. All parts of the switches are of liberal dimensions to provide not only ample current capacity, but also to give a generous margin of safety and thus eliminate the likelihood of failure in operation.

An ingenious patented safety catch or locking device can be applied to any of the switches, although it is not provided unless specified. This locking device is built in between the two blades, thus forming an integral part of the blade structure. It is so arranged that only a single operation of any standard switch hook is required both to release the lock and to open the switch.

In Figs, 1 and 2 are shown front and side views of a 1,000-ampere, 13,200-volt switch mounted upon a flat steel base. The construction of the switch is readily seen from these illustrations, this particular switch being without the locking device. Fig. 3 shows a 300-ampere, 6,600-volt switch arranged for mounting on 1.25-inch pipe; this switch also is without locking device. Figs. 4 and 5 show front and side views of a 2,000-ampere, 6,600-volt double-throw switch with locking device; the switch is mounted on a marble base and has its middle point arranged for back connection. The new switches vary in capacity from 300 to 2,000 amperes, and in voltage from 2,500 to 33,000. The three methods of mounting are shown in the three types of switches illustrated. All of the front-connected switches can be furnished with either corrugated porcelains, post insulators or line insulators.

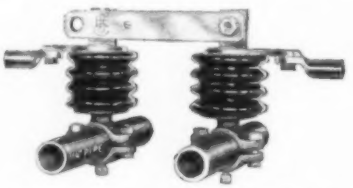
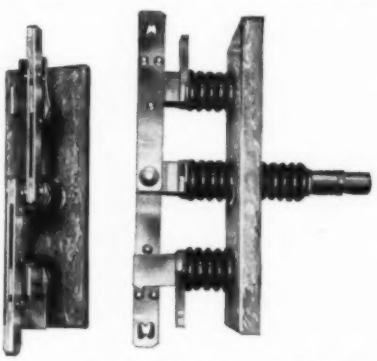


Fig. 3.—300-Ampere, 6,600-Volt Switch with Pipe Mounting.



Figs. 4 and 5.—2,000-Ampere, 6,600-Volt Double-Throw Switch with Locking Device.

New Types of Porcelain Strain Insulators.

To meet the severe requirements due to the increasing weight of overhead construction, two new types of porcelain strain insulators have been developed by the Westinghouse Electric & Manufacturing Company. These are a combination of a metal cap to give the necessary strength and a porcelain skirt to furnish the required dielectric strength.

The metal parts of these insulators consist of a malleable-iron cap, a drop-forged steel eye bolt, and a malleable-iron sleeve by which the eye bolt is securely fastened.

The metal and porcelain parts are cemented together with a high-grade Portland cement. The cemented surfaces are

New Strain Insulator with Skirt Broken to Show Section of Porcelain.

provided with carefully determined corrugations which prevent failure, except by the actual shearing of the cement. The skirt of the porcelain is provided with corrugations on the under side to give additional creepage surface.

Two types of these insulators are made, the PK and the PK-1. The metal parts of the type PK insulator are sherardized and those of the larger size, type PK-1, are not galvanized. The type PK insulator is especially used for insulating cables when the working load does not exceed 1,600 pounds. Being tested at 5,000 pounds these types are generally used for heavy service, such as dead-ending high-strength steel messenger cables, having a working load of 4,000 and 8,000 pounds, respectively.

The drop-forged eye bolt of the type

PK-1 has side projections so that if two or more insulators are used in series they cannot swing more than a few degrees, thus avoiding the danger of breaking the porcelain skirt due to striking the cap of the adjacent insulator.

Detroit Ironclad Entrance Switches.

The increasing use of electrically operated machinery in industrial establishments where many persons devoid of electrical training are employed has called for the development of devices to safeguard such individuals from electrical hazards and incidentally to protect the machinery and circuits more adequately. Among manufacturers who have been quick to meet this need is the Detroit Fuse and Manufacturing Company, Detroit, Mich., which several years ago placed on the

Fig. 1.—Ironclad Entrance Switch.

market its well known ironclad fused switch. This switch carried out the same idea of inclosing in a metal casing knife switches and cutouts that

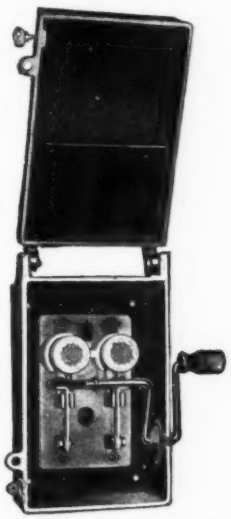


Fig. 2.—Inside View with Switch Closed.

had been found so valuable in protecting circuits by iron conduit.

Since the Detroit ironclad switches met with such general favor, it has been found desirable to extend this line of fittings by specially designing entrance switches on this principle. A few of these are illustrated herewith. Fig. 1 is an outside view of such a switch. This gives a good idea of the general shape of the casing and the position of the operating handle at the right in its "locked off" position. A strong padlock is placed at the left; it prevents any unauthorized person closing the switch while repair work

Fig. 3.—Three-Pole Switch Open.

is being done on the circuit or machinery, and thereby endangering other persons or apparatus. Fig. 2 shows the inside of a two-pole switch with Edison plug fuses. The switch is mounted on a porcelain base which is rigidly secured to the casing. Fig. 3 shows a similar three-pole switch, the switch in this case being open.

These switches are also made for open-link fuses. Their rating is 30 amperes, 125 volts. The switches can be provided with a detachable handle and also with a special positive-make and quick-break device; the latter has a powerful spring to insure firm closed contact and very rapid opening of the switch. When so ordered all switches can be drilled for conduit or equipped with porcelain bushings in accordance with drilling specifications, this being done without extra charge.

New Pass & Seymour Porcelain Socket.

The more rigid enforcement of the Underwriters' rules with reference to

New Porcelain Socket with Aluminum Cap.

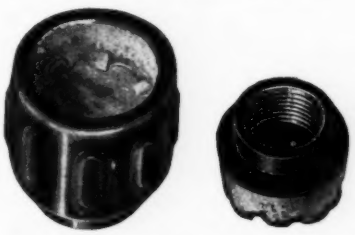
the use of porcelain sockets in many places where dampness abounds has created and greatly increased the demand for sockets of this type that will meet the strict requirements for this service. To meet such increased demands, Pass & Seymour, Incorporated, Solvay, N. Y., has added a new socket to its interchangeable line of porcelain sockets. As shown in the illustration herewith, this is a key socket with durable porcelain body and key, and is provided with one-half-inch aluminum cap. The value of this and other similar sockets with which it is interchangeable is due to the fact that in case a ground should occur on a line, the user is protected by the porcelain shell of the socket. This socket is known as No. 485.

Wirt Drawn-Steel Insulating Joints.

The new Underwriters' rules covering the installation of electric or combina-

Figs. 1 and 2.—Drawn-Steel Shell and Thimble.

tion gas and electric lighting fixtures require the use of insulating joints with double insulation to withstand at either end a test of 4,000 volts alternating current for five minutes. To meet the more rigid requirements now laid down and to make a stronger joint in every way, the Wirt Company, Philadelphia, Pa., has placed on the market a line of drawn-steel insulating pipe couplings that more than answer the purpose. These pipe insulators have a new insulation of the nature of artificial stone, which is molded in place and subsequently hardened; it is known by the trade name Di-el-ite.



Figs. 3 and 4.—Parts After Tensile Test Showing Metal Intact.

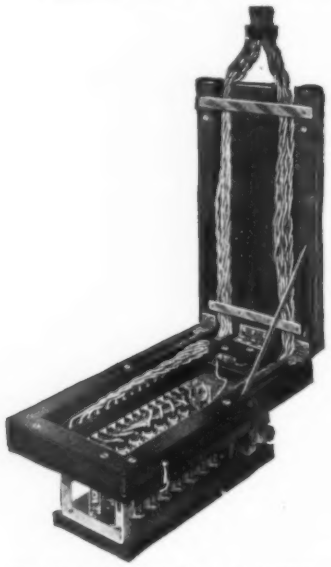
In Fig. 1 is shown the drawn-steel shell for the coupling with its inwardly turned flanges and outer corrugations to give a better grip for the pipe tongs or wrench. Fig. 2 shows the drawn-steel thimble with threaded cap and "pie-crust" flange. This joint was subjected to tensile tests in a testing machine until rupture oc-

curred. The appearance of the coupling shell after the test is shown in Fig. 3 and that of the thimble in Fig. 4. It will be observed that the sample broke from shearing of the insulation and that the steel parts are intact. The sample tested was for three-eighths-inch pipe and withstood a straight pull of 8,000 pounds before breaking apart. These pipe insulators are made in all the standard sizes.

Railway Way-Station Test Boards.

An important part of the equipment of the railway way-station operator's office is a ready means for testing and patching the telephone train-dispatching circuits, so that interruptions to service may be minimized and a remedy quickly applied should such interruptions occur. To meet the demand for an efficient testing and patching device of this kind, the Western Electric Company has developed and placed upon the market what is known as the No. 2 type test board.

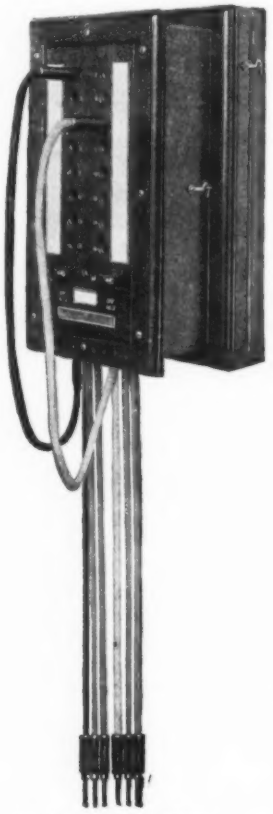
These test boards, the No. 2-A equipped for two metallic circuits and the No. 2-B for four metallic circuits, are made of solid oak and built to withstand more than the ordinary amount of use. The jacks through which the lines are carried are mounted in the face of the board, each with its designation strip. Below these jacks are mounted keys by means of which the selector and telephone equipment is switched from its regular circuit to the patching cords. The patching cords are connected to terminals inside of the test boards and hang from the bottom of the cabinet. These cords are thoroughly moisture-proofed. Wiring is run in twisted pairs and held in place by removable straps.



Test Board Opened for Inspection.

A striking feature of the new test boards is their accessibility for inspection work. A removable cover, held in place by hooks, gives immediate access to all line terminals, while the apparatus board hinged at the lower edge gives access, when opened, to the jack terminals. All wires are visible for inspection when the apparatus board is opened.

The design of the test boards is the result of a careful study of railroad dispatching conditions. It has been found to be general practice to carry the train wire and message wire through the test board, provided two circuits of this kind are installed. If no message wire is installed, it is usual to take two telegraph circuits of iron wire, solder all the joints and transpose the circuit and then bring it through the test board so that it may be used for patching. The telegraph wires may also frequently be brought into the test board even if a message wire has been installed. The point in this is that the train wire, which is the most important, must be kept working in any event, making it necessary to carry the message and telegraph wires through the boards so that they can be used for patching in emergencies.



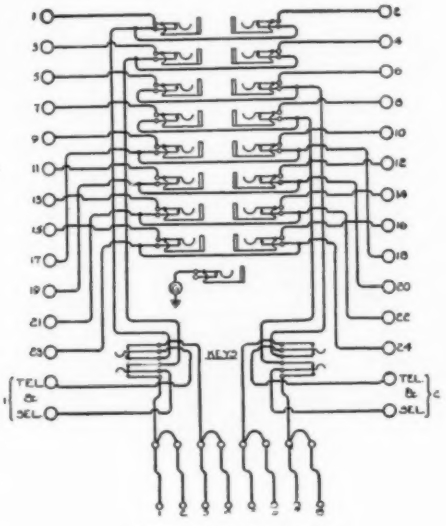
No. 2 Type Test Board.

The new test boards are equipped to make all the tests and patches ordinarily required on train and message wires. They are an essential for roads with a heavy wire traffic where an interruption to service is a serious matter.

An Automatic Controller for Alternating-Current Motor-Driven Machines.

The advantages of alternating current over direct current from the point of view of distribution over considerable distances have long been accepted. For many classes of work alternating current is preferable to direct current from the user's standpoint also.

The difficulty in using alternating current for motor-driven machinery has occurred where a comparatively large range of speed variation is required. Where direct current is used, speed variation is readily obtainable by a slowing down of the motor below normal speed, or a speeding up above normal speed. With alternating current, however, all regulation must be by slowing down of the rotor below normal speed, and where a slow running speed is desired the motor has not sufficient torque to satisfactorily start the load. This is especially true of machines which require a powerful starting effort on the part of the motor, but comparatively little effort to keep the machine going.



Circuits of Test Board.

It has been the practice in such plants as are equipped with alternating current to use hand controllers for operating the motors. With such controllers it is necessary to move the regulating handle up to a point approximating normal speed of the motor, and then, when the rotor starts to revolve, the handle must be quickly moved back to the slow speed at which it is desired to operate the machine. This has been an unsatisfactory arrangement because it meant moving the controller handle over a series of sliding contacts twice for every start, thereby doubling the amount of wear and tear, an important feature in machines frequently started. Moreover, it does not insure continuously uniform speed.

It is generally conceded that the ideal method of operation is by means of a controller on which the speed can be instantly varied by the one in authority, but where the speed will remain absolutely uniform regardless of the number of times the machine is started or stopped. By this method the operator does not have to bother at all about the speed at which he is running, his only concern being to touch a button or to throw in a contactor when he is ready to start or stop, the controller automatically taking care of the proper acceleration, deceleration or stopping of the motor.

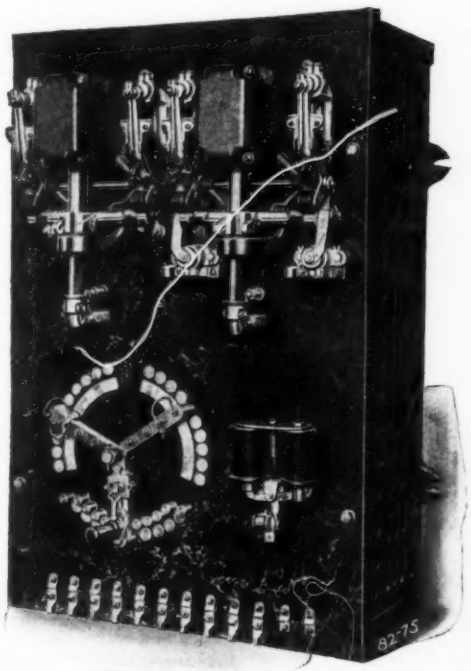
The Monitor Controller Company, Baltimore, Md., claims to have been the pioneer in this class of appliances, having brought out the first automatic control for commercial printing presses some eight or nine years ago. It is now announced that the company has perfected, patented and is prepared to furnish an absolutely reliable controller for either single, two or three-phase alternating-current motors, paralleling in practically all respects the pre-set speed types of direct-current equipments. With alternating-current work the dynamic brake for stopping cannot be furnished and it is therefore necessary to use the foot brake which is furnished with various machines, or else to use a magnetic brake which can be furnished with any standard motor at slight additional cost. This magnetic brake is operated from the controller.

The accessories used with this new type of controller are identical to those used with corresponding types of Monitor direct-current apparatus, that is, starting, stopping, reversing and slight movements of the machine can be accomplished automatically and every movement controlled from a simple station either by push-button or by safety lever, as shown in the illustration herewith.

The distinctive feature of this new controller is that, in starting, a proper amount of resistance is automatically inserted in each phase of the motor, which gives absolutely correct starting characteristics, and is the same under all running conditions. That is to say, the starting effort required of the motor is the same regardless of the position of the regulating handle. After the rotor has attained the proper speed, the starting resistance is automatically cut out by the controller, and the regulating resistance, which has been previously determined by setting of the handle, is automatically thrown in, bringing the motor promptly to the speed desired, which may be any speed between normal and the lowest speed specified. A no-voltage release is provided with these controllers, so that on failure of the line voltage and the consequent stoppage of the motor the entire system is automatically cut out and will not again start on the return of the voltage until the operator has again touched the start button or lever, when the starting cycle is again gone through with. This one feature of the Monitor controller, of itself, is a great improvement over the drum controllers now being almost universally used with alternating-current motors, as with the latter, if the voltage fails and the operator overlooks returning the controller handle to the off position, the machine will start again upon the return of voltage, which is liable to cause serious accidents. If desired, an overload release feature may be added to the regular Monitor controller, at slight additional cost.

These alternating-current controllers have the characteristic rugged construction and absence of sliding contacts or delicate mechanism of any sort. All circuits are made and broken between graphite and copper, and all contacts carrying considerable current are reinforced by laminated copper carrying contacts.

The new controllers are built for single or two-motor drive, depending upon the amount of speed variation desired, and will eventually be built in all sizes. At present they are being furnished for motors whose rotor current does not exceed 150 amperes.



Monitor Automatic Control Panel for Alternating-Current Motors.

Monitor Control Station.

A New 660-Watt Electric Water-Heater.

A 660-watt electric water-heater of entirely new design has been added to the line of water-heaters made by the Cutler-Hammer Manufacturing Company, Milwaukee, Wis. This new heater illustrated below has a water capacity of three quarts and because of its moderate consumption of current can be attached to any lighting circuit when no other load is used thereon.

For the purpose of guarding against waste of current a small pilot lamp is mounted in the base of the heater, under a ruby glass lens, this serving as a signal light to show when the current is on, and as a reminder to switch it off when the heater is no longer required. A flush switch is mounted in the base, the two buttons of which facilitate the operation of switching on and off the current.

New Cutler-Hammer Water-Heater, 660 Watts.

These heaters are of particular use in the cooler months in buffets, restaurants and drug stores where used in dispensing hot drinks at the bar or soda counter or for furnishing hot water for any purpose. In the home they are suitable for furnishing hot water instantly for tea, coffee, cocoa, hot drinks, soups, broths, for the shaving mug or any other purpose for which hot water in small uantities is wanted quickly.

The frosted-glass globe is decorated with cut-glass stars and the base is heavily nickel-plated. The heating unit is of a new type and can be readily renewed.

J-M Fyro Extinguisher for Preventing the Spread of Flames.

Authorities who have made a careful study of the origin, fighting and prevention of fires are agreed that probably 90 per cent of all fires are discovered in their incipient stages and that if devices are available for combating the blaze while it is still a small fire the probability of preventing a large and destructive fire is greatly increased. Statistics are available to show that over 80 per cent of all fires are put out by chemical extinguishers. This shows emphatically the value of such devices and suggests that more liberal provisions should be made for having them available particularly where the liability for a sudden outburst of flame is considerable.

A new portable and very compact

Chemical Fire Extinguisher.

and powerful fire extinguisher has recently been put on the market under the name of J-M Fyro extinguisher. As shown in the accompanying illustration, this extinguisher is of tubular form, three inches in diameter and 15 inches long. On top of the cylinder is a discharge outlet with a small wheel valve. The entire outfit when charged weighs only five pounds. Running through the center of the cylinder from the outlet valve almost to the bottom, is a syphon tube. The cylinder is made of strong seamless brass, subjected to 200 pounds hydraulic pressure and 100 pounds air pressure before it is charged with the fire-extinguishing fluid. The fluid is placed into the outfit and considerable compressed air introduced above its level. This air pressure forces the fluid up the syphon tube, holding it against the outlet valve and thus forming a liquid seal which prevents leakage of air pressure. This arrangement makes the equipment ready for instantaneous use, it being necessary only to open the outlet valve and direct a stream of fluid upon the fire. The pressure is strong enough to throw a stream to a distance of 25 feet and a spray of the fluid to a distance of about 10 feet.

The spray is most effective on small fires scattered over a rather large area. The stream is best for small fires concentrated in one particular spot. The fluid used in the extinguisher is a secret chemical compound which is said to be a liquid gas. When thrown on a fire it instantly volatilizes, forming a dense envelope of combustion-extinguishing gas. This gas is said to be five times as heavy as air and on account of its weight and density, it quickly covers the flames, displaces and prevents the access of free oxygen and thereby extinguishes the fire. One quart of this fluid will expand to 4,000 cubic feet of the fire-extinguishing gas.

Since the fluid used contains no moisture, it is a nonconductor of electricity. It can therefore be used without danger of short-circuiting apparatus, when used on fires of electrical origin. It does not injure the equipment, nor corrode any of the metal parts. It has been found of great value in extinguishing fires on switchboards, in compact electrical machinery, etc. The gas liberated is not poisonous. It does not freeze at even very low temperatures and does not deteriorate or evaporate even in warm rooms.

This fire extinguisher is manufactured by the H. W. Johns-Manville Company, New York City.

A Portable Substation for a Coal Mine.

The Berwind-White Coal Mining Company, Windber, Pa., has recently added a 400-kilowatt Westinghouse portable substation to its equipment and is making a very interesting use of it. This type of substation consists of apparatus for changing alternating current into direct current, and is generally necessary in mining work because direct current must be used for haulage in mines but cannot be transmitted economically over long distances. Hence, when the mine is located some distance away from the power station that serves it electric power can be transmitted more efficiently as alternating current at a high voltage and then transformed to direct current in the substation.

The Berwind-White Company is developing its outlying properties very rapidly and needs direct current at points where permanent substations are not yet erected. In order to prevent delays in the development, the use of a portable substation was decided on. This substation has the same equipment that a permanent installation has, namely, transformers to step down to a moderate value the high voltage of the current received from the transmission line, a switchboard, and a rotary converter that receives alternating current and delivers direct current. All this apparatus is mounted in a car resembling an ordinary freight car.

Portable Substation for Coal Mine.

When the work at a new development reaches the point where direct current is necessary the portable substation is hauled out to the workings, connected to the alternating-current transmission system, and is started to work converting this supply to direct current. When the permanent substation is built, the portable one becomes unnecessary and is taken to the next development.

A further use of this substation is to provide insurance against shutdowns. If accidents occur at any of the permanent substations, the portable outfit is sent to carry the load until repairs are completed. One portable substation, therefore, is practically the equivalent of a duplicate set of apparatus at each permanent substation.

Current Electrical News

LIGHTING AND POWER.

(Special Correspondence.)

SLOAN, IOWA.—A municipal lighting plant is under consideration. Address the city clerk.

BOVEY, MINN.—Additional street lights have been petitioned for. Address the city clerk.

PUNTA GORDA, FLA.—The Council will improve the electric plant. Address the mayor for particulars.

CLEVELAND, O.—The Cleveland Electric Illuminating Company will build a new power plant which will cost $6,000.

JAMESTOWN, PA.—The Dale Light, Heat & Power Company is preparing plans for extending the lighting system.

FT. SMITH, ARK.—A municipal electric light plant will be established here. Address the city clerk in regard to this project.

SUSANVILLE, CAL.—A franchise for transmitting electricity in Lassen County has been granted to the Lassen Electric Company.

FRESNO, CAL.—A committee has been appointed to secure designs for electroliers to be installed in the business district of this city.

ALVISO, CAL.—The Pacific Gas & Electric Company has applied for a franchise here. Bids will be received for the sale of the same up to January 5.

HAMILTON, MO.—The Lee Bookage Company of Kansas City has received a franchise for lighting the city streets and constructing an electric railway.

WAKEFIELD, MICH.—The Council is planning ways and means to establish electric lighting. Address the city clerk in regard to this project.

CINCINNATI, O.—The Columbia Gas & Electric Company plans to establish a new generating plant in Cincinnati. Address Secretary Wickham.

BIRMINGHAM, ALA.—Upon recommendation of Light Inspector Higgins, tungsten lights are to be installed for street lights in all parts of the city.

ONEONTA, N. Y.—The Oneonta Light & Power Company plans to install additional equipment. Address G. A. Lane, manager, for information.

BELLEFONTAINE, O.—This city is ready to issue bonds in the amount of $36,000, the proceeds to be used to improve the local electric-lighting plant.

NATIONAL CITY, CAL.—The San Diego Consolidated Gas & Electric Company has been awarded a five-year contract for street lighting in this city.

JOHNSTOWN, PA.—The mayor recommends the termination of the city's lighting contract and the erection of a municipal plant. Joseph Cauffiel is mayor.

AURORA, MINN.—Plans are being prepared for the construction of an addition to municipal electric light plant here. Address the city clerk for information.

SEQUATCHIE, TENN. — Motors will be used in the operation of a knitting mill, which will be established by E. G. Wright, who is now organizing a company. G.

CHATEQUAY, N. Y.—The Chasm Power Company plans to erect about five miles of 13,200-volt transmission line. Address W. T. Thayer, manager, in regard to the matter.

MT. VERNON, ILL.—The Citizens' Gas, Electric & Heating Company has applied for a franchise to extend its lighting system. Address H. E. Brandi, manager, for particulars.

COVINGTON, PA.—Covington Electric Light Company has been incorporated with a capital stock of $5,000; also the Covington Township Electric Light Company, capitalized at $5,000.

HADDONFIELD, N. J.—The Commissioners are considering the proposition of running the municipal lighting plant in conjunction with the water works. The estimated cost will be about $6,000 a year.

RANTOUL, ILL.—The City Council has decided to purchase a new transformer for the municipal electric light plant and to change the street lighting system from arcs to tungstens.

PORTLAND, ORE.—James Lindsey has been granted a permit by the Department of Agriculture for the construction of a power plant on Mill Creek in Douglas County within the Siuslaw reserve.

MOUNT JOY, PA.—The Edison Electric Company has received a contract from Burgess Hoffman, of Mount Joy, Pa., to light the streets of the borough for $1,623 a year for 114 lights. N.

WARREN, PA.—Directors of the Warren Street Railway Company have decided to build a trolley line from Warren to Youngsville, nine miles, and work will be started shortly after the first of the year.

CLEVELAND, O.—The F. Zimmerman Company, molding manufacturers, 1723 Leonard Avenue, has under construction a power plant in addition to its factory and is said to be in the market for equipment. R.

CANTON, O.—The Knight Tire & Rubber Company is said to be in the market for an 80-horsepower motor and other electrical accessories, made necessary through enlargement of the plant and doubling the mechanical equipment. R.

RAYMOND, WASH.—The Willapa Electric Company will build a power plant with a capacity of 1,000 horsepower adjoining the plant of the Willapa Lumber Company. Active operations will begin in the immediate future. O.

HARRISON, N. J.—The Board of Trade has appointed a committee to confer with the Common Council regarding the installation of a flaming-arc street-lighting system on Harrison Street, from Davis Avenue to the Bridge Street bridge. A.

PHILADELPHIA, PA.—The Wilmington & Philadelphia Traction Company reports that it will construct four miles of 6,600-volt three-phase transmission line in the near future. J. A. Berndt, is the company's purchasing agent. N.

MONTESANO, WASH.—The Elma Light & Power Company recently gave a mortgage deed to The Title Trust Company for a bond issue of $50,000, and from an authentic source comes the report that some needed improvements will be made. O.

INDEPENDENCE, ORE.—The Council has authorized contracts with the Oregon Power Company, a subsidiary of the Northern Idaho & Montana Power Company, for city lighting and city water service. Both contracts will cover five-year periods.

CENTRALIA, WASH.—The City Council is considering the proposition of extending the lighting service to West Main Street, beyond the improved section, as residents of that district have petitioned for the service. The city engineer has been instructed to make an estimate of the cost. O.

SUMMIT, N. J.—In connection with the renewing of its lighting contract with the Commonwealth Water & Light Company, the Board of Trade is considering the installation of new 32-candlepower lamps to replace the 25-candlepower now in service. Carroll P. Bassett is president of the Commonwealth company.

MONONGAH, W. VA.—The Fairmont & Clarksburg Power Company will construct two hydroelectric plants, developing respectively 10,000 and 60,000 horsepower. The plans include two concrete power dams and two hollow-type reinforced concrete storage dams. The cost is estimated at $280,000.

PHOENIX, N. Y.—The Phoenix Gas & Electric Company has been incorporated with a capital stock of $40,000 by Herbert Dunn, J. A. Haws and others. The company proposes to furnish gas and electricity for the residents and streets of the village, and power for manufacturing companies in that vicinity.

CLEVELAND, O.—The Council has authorized the purchase and installation of 18 500-kilowatt transformers and cable for the new municipal light plant. It was arranged that $18,504 be spent for transformers and $37,000 for cables. W. J. Springborn is director of public service; R. E. Collins, city clerk. R.

COACHELLA, CAL.—The Coachella Valley Ice & Electric Company has applied to the Railroad Commis-

sion for permission to issue bonds of the aggregate face value of $300,000, the proceeds of which are to be devoted to the construction of electric distributing lines in and around Coachella.

PORTLAND, ORE.—Will H. Daly, Commissioner of Public Utilities, recently announced that the City of Portland will instruct the Portland Railway, Light & Power Company to install arc lights in the Laurelhurst District, to replace the gas cluster lights now in use. This improvement will be ordered in the immediate future. O.

SPOKANE, WASH.—Stockholders of the Washington Water Power Company recently authorized an increase in capitalization of $5,000,000, raising the total to $20,000,000, the bulk of the proceeds of which will go toward the construction of a power plant on Long Lake. Several small towns in the Coeur d'Alene Mining District will be connected up with power lines. O.

CLEVELAND, O.—Steps to compel public utilities to eliminate all overhead wiring along streets on which car lines run are proposed in a plan mapped out by Mayor Baker at a conference with Director of Public Service Springborn and City Electrician Sarbinsky. Telephone and light companies would have to place under ground approximately 125 miles of wiring. R.

PHILADELPHIA, PA.—Pursuant to the plans of the Lehigh Valley Transit Company when the Lehigh Valley Heat & Power Company was reorganized a year ago, 14 more charters for electric companies in Bucks and Susquehanna counties have been granted. The capital of each is fixed at $5,000 though all are owned by the Lehigh Valley Light & Power Company.

CHICAGO, ILL.—Monroe Street will become a great "White Way," if the plans of property owners on the street materialize. A meeting was held of the Monroe Street Improvement Association and H. A. Seward, elctrician and construction engineer, was instructed to take steps to secure frontage consents and obtain estimates on the cost of installing a lighting system similar to that now used on Dearborn Street.

SEATTLE, WASH.—Complete developments of the Cedar River power project, the municipal system, to a capacity of 45,000 kilowatts will cost in addition to what has already been expended $3,320,000, according to figures recently submitted to the City Council by Lighting Superintendent J. D. Ross. The propositin of condemning the Lake Cushman site and constructing a 70,000-horsepower plant on same is now before the City Council for final action O.

CINCINNATI, O.—In recent statement P. H. Kimble, manager of the electric department of the Union Gas & Electric Company, a subsidiary of the Columbia Gas & Electric Company, told something of the plans for the erection of a new central generating station in Cincinnati. The new station will represent an expenditure of $3,000,000 and it is to be erected on the site of the West End gas plant. It was planned to make an initial installation of 50,000 horsepower, but the growth of electric consumption in Cincinnati has been so rapid in the last year that the plan of making the first installation between 80,000 and 100,000 horsepower is under consideration.

TELEPHONE AND TELEGRAPH.

(Special Correspondence.)

OSKALOOSA, IOWA.—The rural lines of the Home Telephone Company will be rebuilt. C.

HERMAN, MINN.—H. B. Johnson and others are organizing the Macsville Telephone Company. C.

MILDRED, MINN.—Farmers Telephone Company has been organized by Albert Eastvold and others and lines will be built in every direction.

MORO, ILL.—The Farmers' Telephone Company contemplates building a new toll line between Moro and Bethalto. Z.

RIVERSIDE, CAL.—Sealed bids will be received up to December 29 for a telephone and telegraph franchise in this city.

IPAVA, ILL.—The Village Board has granted a 20-year franchise to O. W. Stubblefield to operate a telephone exchange in Ipava. Z.

CENTRALIA, WASH.—The Salzer Valley Telephone Company has been granted a franchise for a line up Salzer Valley, east of Centralia.

BLAIRSTOWN, N. J.—The Patrons' Telephone Company will extend its system to Hainesburg and surrounding territory in the Paulus Kill Valley.

HASTING, IOWA.—The Hastings Mutual Telephone Company has been incorporated by George Shaw who is president; J. E. Martin and others.

NORTHOME, MINN.—The Northome Telephone system has been purchased by George A. Semon and will be connected with the Mizpah system.

SEARS, ILL.—The Automatic Home Telephone Company has been granted a franchise by the Village Board to construct and operate a telephone exchange in Sears. Z.

McGREGOR, N. D.—The Tri-County Telephone Company has been incorporated with a capital stock of $25,000, by Paul P. Tunseth, Nels Langerberg and others.

LODI, WIS.—The Dane Telephone Company has been incorporated and it is probable that the central office will be located at Dane, connecting with the Lodi and having a Waunakee exchange. C.

LINDSAY, CAL.—The Lindsay Home Telephone Company has applied to the Railroad Commission for authority to execute a note for $5,000 for the purpose of making extensions to its lines and for paying existing indebtedness.

PORTLAND, ORE.—The Pacific Telephone & Telegraph Company, Fred Spoeri, manager, contemplates the expenditure of approximately $50,000, for improvements and repairs to the plants and cable systems in the business district. O.

DOUGLAS, ARIZ.—The farmers of the lower Sulphur Springs Valley are organizing an independent telephone company to construct a telephone system in that section. H. D. DuBois, secretary of the Chamber of Commerce here, is encouraging the movement.

PENDLETON, ORE.—The Pacific Telephone & Telegraph Company, of which O. C. Brill is district engineer, contemplates making changes in the local telephone plant which include the placing of this city on the main toll line, aside from other extensive improvements, which are to be commenced in the immediate future. O.

SEATTLE, WASH.—Farmers of Richland Valley are preparing for a country telephone system. A company is being organized under the name of the Yakima & Columbia River Telephone Company. The officers are E. E. Floyd, president; J. R. Gardener, vice-president; William Read, secretary.

ELECTRIC RAILWAYS.

(Special Correspondence.)

HELENA, MONT.—The matter of the construction of an interurban between Helena and Hauser Lake is being discussed by the Commercial Club. C.

MILL VALLEY, CAL.—Bids will be received by the Board of Trustees of this city up to January 13, for a street-railroad franchise over certain streets.

HAMILTON, MO. — David Miller and H. L. Gilbert, of Kansas City, have been granted franchises for an electric light and electric railway here. The railroad will connect Hamilton and Kingston.

PORTLAND, ORE. — George F. Heusner has been granted a franchise for an electric railway line from the Kenton district to the west side business section. The estimated cost of the line is $350,000.

CHARLES CITY, IOWA.—The Charles City & Western Railway plans to extend its lines and change to electric power. C. W. Hart is general manager. It is planned to extend the railway to meet the Great Western northeast of Charles City.

PUYALLUP, WASH.—The Tacoma Transit Company, which proposes operating an auto bus line between this city and Tacoma, was recently incorporated with a capitalization of $30,000. J. P. Hickey is president of the company, and Guy E. Kelley, here, secretary. O.

ISMAY, MONT.—George Burt, promotor of an electric railway line between this city and Ekalaka, recently announced that his company is preparing to incorporate for $400,000, par value of stock being $100 per share, and that actual work of construction will begin early in 1914. O.

FRESNO, CAL.—A. V. Taylor, a large land owner in the vicinity of Hanford, has offered to subscribe $30,000 if the Fresno-Hanford & Summit Lake Railroad Company will build the 20 miles of its first unit to Hanford in place of Selma or Sanger. Directors of the company are considering the offer.

CLEVELAND, O.—Directors of the Cleveland Railway Company have approved a contract with the Cleveland Interurban Railway Company, making possible a new street car line to Shaker Lakes. The Cleveland Interurban Railway Company, owned by the Van Sweringen real estate interests, has laid tracks through the big Shaker Lakes allotment.

WENATCHEE, WASH.—The Chelan County Commissioners have granted a 50-year franchise to Hyman Harris to construct 35 miles of electric interurban from Malaga to Leavenworth, in the Wenatchee Valley, on the condition that he will complete the line in five years. Harris will apply for a franchise in Wenatchee at once. It is

understood he has sufficient capital back of him to begin operations as soon as the franchises are granted. O.

MORRIS, ILL.—Articles of incorporation have been filed with the recorder of Grundy County by the Illinois Midland Railroad, with capital stock of $25,000. It is proposed to construct an interurban road from Clarke City, Kankakee County through Grundy, Kendall and La Salle Counties to the north line of Winnebago County. The incorporators are Samuel Durant, Philadelphia; F. S. Munro, Highland Park, Ill.; S. N. Ware, Oscar Ware and L. A. Zielke, Chicago. Z.

DULUTH, MINN.—The street railway company, for which Col. A. A. Harris obtained the franchise in West Duluth, has been organized and articles of incorporation filed. It will be known as the City Railway Company of Duluth and is organized to build and operate street railway lines in St. Louis County, Minn., and Douglas County, Wis. The capital stock is fixed at $600,000, and the incorporators are A. H. Burke, D. H. Stevenson and Henry E. Harris of Duluth, Patrick R. Haley and L. J. Matthews of West Duluth, and William C. Green of Chicago.

NEW INCORPORATIONS.

ROCKFORD, ILL.—Ellis Electric Company has been incorporated with a capital stock of $5,500 to do a general electrical contracting business. T. C. Ellis and G. Ellis are among the incorporators.

INDIANAPOLIS, IND.—Bennett Electric Company has been incorporated with a capital of $10,000 to deal in office supplies. The directors are J. H. Anderson, M. L. Anderson and John Anderson.

NEW YORK, N. Y.—W. & W. Electrical Contracting Corporation has been incorporated with a capital stock of $2,000 by Jewell Williams, M. M. T. Williams and J. W. Wellington, all of New York City.

SOLVAY, N. Y.—Solvay Electric Company, Incorporated, has been incorporated with a capital stock of $1,000 by Frank E. Tubridy, Romeyn Wormuth and Clarence E. Cashore, all of Syracuse, N. Y.

NEW YORK, N. Y.—Pitkin Ruby Corporation has been incorporated to manufacture electrical equipment. The capital stock is $5,000 and the incorporators are James T. Halliman, Theodore J. Groh and Joseph P. Barbieri.

PHOENIX, N. Y.—Phoenix Gas & Electric Company, Incorporated, has been incorporated to manufacture and sell gas and electricity. The capital stock is $40,000 and the incorporators are Herbert Dunn, L. M. Hutchinson and J. A. Hawks, all of Phoenix.

CHICAGO, ILL.—Lucas Electrical Device Company has been incorporated with a capital of $10,000 to manufacture and sell electric and mechanical machinery, devices, etc. The incorporators are Mellen C. Martin, Herbert Bobb, and Earl O. Taylor.

MORTON, ILL.—The Getz Power Washer Company has been incorporated with a capital stock of $25,000 to manufacture and deal in washing machines. The incorporators are John B. Getz, George T. Bean and Hiram E. Todd. Z.

NEW YORK, N. Y.—L. Goldberg, and Company, Incorporated, has been incorporated with a capital stock of $1,000 to deal in gas and electric fixtures. The incorporators are Louis Rosenberg, Brooklyn, N. Y.; Annie Goldberg and Louis Goldberg, of New York City.

NEWARK, N. J.—The Public Service Building Company has been incorporated as a subsidiary of the Public Service Corporation with a capital of $200,000, to operate in all phases of electric, railway and gas construction, including the building of cars, structures, transmission lines, etc. Percy S. Young, L. D. H. Gilmour and E. A. Armstrong are incorporators. A.

FOREIGN TRADE OPPORTUNITIES.

(Where addresses are omitted they may be obtained from the Bureau of Foreign and Domestic Commerce, Washington, D. C. In applying for addresses refer to file number.)

NO. 12,099. ELECTRICAL APPARATUS.—A report from an American consular officer in the Near East states that a new dealer, who seems to be possessed of energy and business ability, has opened an establishment for the sale of electrical supplies and sundries, such as incandescent lamps, lightning rods, wet and dry batteries, electric fans, electric torches, cigarette lighters, and other electric novelties.

NO. 12,102. ELECTRIC METERS. A report from an American consular officer in a European country states that a resident of his district, who is able to furnish good references, is desirous of representing American manufacturers of electric meters without collectors.

NO. 12,105. ELECTRICAL MACHINERY, TURBINES, AND TRAMWAY EQUIPMENT.—An American consul reports that a foreign Government contemplates the development of some of its waterpower resources for industrial purposes and possibly for motive power for a light railway. It is estimated that the cost of this work will be about $3,000,000. The engineer who will have charge of the undertaking would like very much to secure from the United States any information available from manufacturers as to electrical machinery, turbines, and tramway equipment.

NO. 12,107. WATER-POWER DEVELOPMENT.—An important contractor and member of a foreign legislature calls the attention of an American consul to the opportunity presented for the development of certain water-power resources, which could be used advantageously in many industries. He states that he would like very much to show this source of water power to any American capitalist who might be interested, and believes that if they would take the matter up a concession could be readily obtained from the local government.

NO. 12,108. TRAMWAY AND ELECTRIC LIGHTING SYSTEM. — The American consul at Jerusalem advises that companies desiring to compete for the adjudication of a tramway to be constructed at Jerusalem, and for the establishment of an electric-light system for the same city, in accordance with conditions which have been distributed, will have to present their bids to the Commission of Adjudication, which will be constituted at the Conak of the Government at Jerusalem. The concession will be granted for 40 years.

PROPOSALS.

SWITCHBOARD, ETC.—Bids will be received on December 29 at the Philadelphia office of the Commanding Officer, Frankford Arsenal, Philadelphia, Pa., for the installation of one steam turbine generator with exciter and switchboard and one condensing equipment in the engine room of the power plant at Frankford Arsenal.

ARC LAMP GLOBES.—Bids will be received until December 23 for furnishing and delivering to the Department of Electricity, Chicago, Ill., sundry kinds and sizes of globes for arc lamps, including 1,025 dozen outer globes for arc lamps, 900 dozen inner globes, heat resisting for arc lamps. Address Ray Palmer, city electrician.

TELEPHONES AND ELECTRICAL SUPPLIES.—Sealed proposals will be received at the office of the Chief Signal Officer, War Department, Washington, D. C., until January 5, 1914, for furnishing under Circular 686 75 large time-interval bells, 35 small time-interval bells, 400 fuses, 5,000 fuses, 150 fuses, 40 extension bells, etc. For further information address W. L. Clarke, major, signal corps, U. S. army, Disbursing Officer.

INCANDESCENT TUNGSTEN LAMPS.—Bids will be received until December 23 for furnishing and delivering to the City of Chicago, incandescent tungsten lamps for the year 1914, consisting of 6,000 25-watt 115-volt tungsten drawn-wire filament lamps; 25,00 80-watt 4-ampere series tungsten lamps; also lamps of such other wattage as may be required from time to time during the year 1914. Address Ray Palmer, city electrician, Chicago, Ill.

ELECTRIC CONDUIT AND WIRING AND INTERIOR LIGHTING FIXTURES.—Sealed proposals will be received at the office of the Supervising Architect, Washington, D. C., until January 19, 1914, for furnishing the electric conduit and wiring and interior lighting fixtures of a one-story building for the post office at Bellaire, O.; until January 26 of a two-story building for the post office at Bedford City, Va.; and until January 27 of three-story building for the post office at Clarksdale, Miss. Copies of drawings and specifications may be obtained from the custodians of the sites or the office of the Supervising Architect.

MISCELLANEOUS ELECTRIC APPLIANCES.—Sealed proposals will be received by the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., until December 23 for furnishing 20,000 feet of flexible double silk conductor, as per Schedule 6,089 for delivery at the Navy Yard, Brooklyn, N. Y.; until December 30 for furnishing 30 headgears for radio receiving sets and one 7.5-horsepower motor, 125 volts, complete, as per Schedule 6,120 for delivery at the Navy Yard, Brooklyn, N. Y., and also one seven-panel switchboard, as per Schedule 6,112, for delivery at the Navy Yard, Key West, Fla.; until January 6 for furnishing one electrically operated dishwashing machine, as per Schedule 6,106, for delivery at the Navy Yard, Puget Sound, Wash.; one motor-driven pump, as per Schedule 6,102, for delivery at the Navy Yard, Mare Island, Cal.; two 75-horsepower induction motors, and one switchboard panel, as per Schedule 6,103, for delivery at the Navy Yard, Tiburon, Cal.

FINANCIAL NOTES.

At a meeting of the Oakland Railways Company, held in San Francisco, stockholders approved the plan to increase the bonded indebtedness $1,000,000 to meet present requirements.

Notice has been filed by the Central District Telephone Company, of Philadelphia, of an increase in its capital from $15,000,000 to $25,000,000 and of the creation of an indebtedness of $25,000,000.

The West End Street Railway has petitioned the Massachusetts Public Service Commission to approve the issue of 7,000 additional common shares, par $350,000 to be sold at public auction and issue of $600,000, 30-year six-per-cent bonds, proceeds to reimburse Boston Elevated for expenditures on property of $992,950.

At a special meeting of the stockholders of the Federal Light & Traction Company an issue of $10,000,000 seven-per-cent 10-year notes, previously authorized by the board of directors, was approved. Of this amount $725,000 will be offered to stockholders at par and interest. Stockholders also approved an underwriting agreement between the directors and firms, with which the directors are identified, to take up such notes as are not subscribed for by stockholders.

Interborough-Metropolitan's $1,800,000 two-year six-per-cent notes, falling due December 22, will be partly paid off and the remainder extended for probably six months or a year. The loan was made in December, 1911, through Hallgarten & Company, to enable Interborough-Metropolitan to pay its assessment on the shares of the Metropolitan Street Railways Company, under the reorganization plan. New York Railways stock owned by Interborough-Metropolitan was pledged as collateral for the notes.

Announcement is made that the Northern Connecticut Securities Company, Connecticut and Massachusetts concern, has acquired the Coffin interests in the Connecticut River Company, ending a six-year contest. Contracts provide that the Northern Securities Company acquire practically all the stock held by the Coffin interests, but Arthur D. Coffin, of Windsor Locks, is to remain a director. The agreement carries with it the right to purchase lands and flowage rights necessary to the development of the big water power at Windsor Locks. The Connecticut River Company was organized in 1828, and since 1831 has operated the canal between Windsor Locks and Enfield.

Mortimer Fleishhacker, president of the Great Western Power Company, who has been in the East arranging for the purchase of electrical equipment for the increase of the capacity of the Big Bend power station of the company from 40,000 to 60,000 horsepower, has returned to San Francisco. It is understood that all funds for the purchase of this equipment are in hand and no new financing will be necessary until the company is ready to install one of the four additional plants.

The Milwaukee Electric Railway & Lighting Company has sold to New York bankers $807,000 of its general and refunding five-per-cent mortgage bonds, the bonds being issued under the terms of the mortgage for extensions and additions to the property. The issue of these bonds makes the amount now outstanding $5,305,000, with $6,500,000 reserved to retire the consolidated 5s, due in 1926, and $6,728,000 reserved to retire the refunding and extension mortgage 4.5s, due in 1931. The authorized issue of the general and refunding bonds is $90,000,000.

H. E. Huntington will be elected president of the recently incorporated Los Angeles Railway Company, under which all the street railways of Los Angeles have been consolidated. Pending Mr. Huntington's return to Los Angeles some time after the first of the year, W. E. Dunn has been elected president but later Mr. Huntington will become president, Howard Huntington first vice-president and Mr. Dunn, second vice-president. The directors elected for the new company are W. E. Dunn, S. M. Haskins, Albert Crutchers, J. E. Brown, G. C. Ward, Frank Griffith and C. A. Henderson. The new company will ask permission of the California Railroad Commission to issue $23,500,000 bonds to retire $20,000,000 bonds of the Los Angeles Railway Corporation and $3,500,000 bonds of the City Railway Company. The commission also will be asked to permit the cancelation of the $5,000,000 stock of the City Railway Company and to limit the stock of the new company to $20,000,000, thus reducing the capitalization of the merged companies by $5,000,000.

Stockholders of the Washington Water Power Company have authorized an increase in capitalization of $5,000,000, raising the total issue from $15,000,000 to $20,000,000, the bulk of the proceeds of which will go toward paying for the Long Lake power plant. "We intend shortly to offer to present stockholders the right to subscribe one-tenth of their present holdings, and, as $14,081,900 of the capital stock is now outstanding, this will mean the raising of $1,408,190 immediately," said President D. L. Huntington. "The present increase is expected to take care of improvements for several years. Warrants for the new stock will be sent to the stockholders of record December 2, so as to reach them by January 1." Mr. Huntington said that a portion of the expected funds would go into improvement of plants purchased throughout last summer at Pullman, Palouse, Colton and Uniontown, Wash., and Moscow, Troy, St. Maries and Genesee, Idaho, as well as to some extension of farmer power lines.

The filing of a trust deed covering a bond issue of $5,000,000 with the Union Trust Company of San Francisco as trustee contains an intimation that the Oakland, Antioch & Eastern is contemplating an extension of its lines from Oakland to Stockton. At present the company operates between Oakland and Sacramento, but the deed of trust covers rights of way in San Joaquin and Contra Costa counties to Stockton.

The Tidewater Southern, which operates between Stockton and Modesto, some time ago planned to extend its line to Oakland. In connection with the proposed extension was tied up the effort of the Oro Electric Corporation to enter Stockton in competition with the Western States Gas & Electric. When the state railroad commission denied the application of the Oro Electric, the railroad extension also failed. It is thought that the Oakland, Antioch & Eastern now contemplates the use of the survey and rights of way which the Tidewater Southern secured between Stockton and Oakland.

Announcement is made that the directors of the Cities Service Company have approved a plan for the purchase of the properties of the Utilities Improvement Company and the Consolidated Cities Light, Power & Traction Company, the proposition having been approved also by the boards of the other two corporations. Under the plan of consolidation the six-per-cent preferred stock of Cities Service Company will be exchanged, share for share, for the six-per-cent preferred stock of Utilities Improvement Company and one share of Cities Service common stock will be exchanged for two shares of Utilities Improvement common stock. For each two shares of the capital stock of Consolidated Cities, Light, Power & Traction Company one share of Cities Service will be exchanged. Under the consolidation the position of the Consolidated Cities Light, Power & Traction five-per-cent bonds will remain unchanged, as they will continue to be secured by the same collateral and other assets as when issued. Dividends of five per cent a year are now being paid on Cities Service common stock, and these will be increased to six per cent, with the payment to be made February 1, 1914. With the consolidation completed and all stocks exchanged the capitalization of Cities Service Company will consist of $27,368,426 of six-per-cent preferred stock, $15,718,380 common stock and $5,000,000 five-year seven-per-cent notes. Exchange of stocks under the plan will be made after December 15.

Reports of Earnings.

MEXICAN TELEPHONE & TELEGRAPH.

The Mexican Telephone & Telegraph Company reports earning for the six months ended August 31, 1913, as follows (Mexican currency):

	1913.	1912.
Gross	$ 376,320	$ 348,187
Expenses	194,787	166,341
Net	181,432	181,846

CUMBERLAND COUNTY POWER & LIGHT.

	1913.	1912.
October gross	$ 204,249	$ 176,976
Net after taxes	88,363	78,612
Surplus after charges	24,628	22,102
Twelve months gross	2,306,150	2,109,285
Net after taxes	1,019,891	883,381
Surplus after charges	319,749	252,094
*Balance after preferred dividends	193,749	184,594

*Equal to 7.2 per cent on common stock.

CLOSING BID PRICES FOR ELECTRICAL SECURITIES ON THE LEADING EXCHANGES AS COMPARED WITH THE PREVIOUS WEEK.

	Dec. 15	Dec. 8
American Tel. & Tel. (New York)	115⅝	119½
Commonwealth Edison (Chicago)	127¾	127¾
Edison Electric Illuminating (Boston)	236½	261
Electric Storage Battery common (Philadelphia)	46	46¾
Electric Storage Battery preferred (Philadelphia)	46	46¾
General Electric (New York)	137¼	139
Kings County Electric (New York)	119	119
Manhattan Transit (New York)	1¼	1¼
Massachusetts Electric common (Boston)	10½	10½
Massachusetts Electric preferred (Boston)	65	66
National Carbon common (Chicago)	130	130
National Carbon preferred (Chicago)	110	110
New England Telephone (Boston)	131	133½
Philadelphia Electric (Philadelphia)	25⅜	25⅞
Postal Telegraph and Cables common (New York)	77	79
Postal Telegraph and Cables preferred (New York)	65	65½
Western Union (New York)	60	62
Westinghouse common (New York)	63¼	65¼
Westinghouse preferred (New York)	112	112

PERSONAL MENTION.

MR. H. J. HART, of Salem, N. J., has been elected president of the Pennsgrove Electric Light, Heat & Power Company, Pennsgrove, N. J.

MR. STROTHERS J. BANKS, for some time connected with the Buckeye Electric Works of the General Electric Company, is conducting a very successful Buckeye department for the Post-Glover Company, of Cincinnati, O.

MR. MEYER J. STURM, a prominent Chicago architect and member of the Chicago Commission on Ventilation, presented a paper on ventilation before the Western Society of Engineers on the evening of December 15.

DR. ALEXANDER GRAHAM BELL has been awarded the Hughes medal by the Royal Society on the ground of his share in the invention of the telephone, and more especially the construction of the telephone receiver.

MR. JOSEPH W. PETERS has been appointed secretary of the Board of Managers of the Association of Engineering Societies, with offices at 3817 Olive Street, St. Louis, Mo., at which place the *Journal of the Association of Engineering Societies* will be published.

MR. T. T. RICHARDS has been appointed assistant sales manager of the Wagner Electric Manufacturing Company, St. Louis, Mo. Mr. Richards has been associated with the Wagner Company's sales department for nine years, specializing in the marketing of the new devices produced by this company.

MR. W. L. R. EMMET read a paper entitled "Power From Mercury Vapor" before the Schenectady Section of the American Institute of Electrical Engineers on the evening of December 16. This paper describes a process by which it is expected to increase the energy obtainable from coal or oil by about 50 per cent.

MR. THEODORE N. VAIL, president of the American Telephone & Telegraph Company, has predicted that the telephone will probably be in use between New York and San Francisco by the time of the Exposition. Mr. Vail said "We have already had experiments and the voice was as distinct as it is in this room."

MR. ROLAND FITCH, for several years connected with the Bowling Green (Ky.) plant of the Kentucky Public Service Company, has been promoted to the position of manager of the plant, succeeding his brother, MR. HENRY D. FITCH, who has been appointed general manager of the company, in charge of lighting properties in four cities.

MR. CHARLES E. BUSH, formerly of Tulsa, Okla., and one of the men who negotiated the recent loan of $250,000 to the Tulare County Power Company, has accepted the position of general manager of that company, with headquarters in Tulare, Cal. MR. C. E. TAYLOR, who was formerly line manager for the company, is at present representing the trustees for creditors of the Tulare Company.

DR. MICHAEL I. PUPIN' addressed the New York Electrical Society at its meeting which was held in the Engineering Societies Building, New York City, on December 18, on the subject of "The Science and the Art of the Pupin Coil." Dr. Pupin discussed the scientific principles of the Pupinized line, and the engineering work involved in the development of the various elements of which it is constituted.

MR. J. G. WHITE returned on Wednesday, December 10, on the *Olympic* after six months absence in England and the Continent. Much of his time was spent in London at the home office of J. G. White & Company, Limited, of which he is president. One of the important recent financial undertakings of that company is the formation of the International Light and Power Company, Limited, a holding company owning securities in several Electric Light and Tramway properties throughout South America.

MR. A. K. YOUNG, who for the past two years has been in charge of the New Business Department and the Commercial Department of the Brush Electric Company, Galveston, Tex., has been moved to New York City, where he will take charge of a department of a special nature with the Doherty Company. MR. R. A. WOOD, of Warren, O., succeeds Mr. Young in Galveston. Mr. Young is among the prominent electrical men of the United States and has been with the Doherty Company for the past nine years, during which time he has filled almost every position in the various offices. He spent two years in Denver, Colo., two years in Cincinnati, O., one and one-half years in Montgomery, Ala., one and one-half years in Bristol, Va., and two years in Galveston.

MR. M. C. GILMAN has been appointed sales manager of the Toronto Electric Light Company, Limited, of Toronto, Ontario, Can., vice Mr. W. R. Sweany. Mr. Gilman was graduated from the electrical engineering course at Pratt Institute, Brooklyn, N. Y., in 1907, and since then has had the following experience in the central station field: assistant power engineer, Edison Electric Illuminating Company, Brooklyn, N. Y.; assistant power engineer, Public Service Electric Company, Newark, N. J.; power engineer, Virginia Railway & Power Company, Richmond, Va.; and power engineer, the Toronto Electric Light Company, Limited, Toronto. For the past year Mr. Gilman has served as assistant to Mr. F. G. Clark, chief engineer of The Toronto Electric Light Company, Limited, from which position he is now promoted to that of sales manager.

OBITUARY.

DR. HENRI SIMON, chief of the radiographic service in the Cantonal Hospital, Geneva, Switzerland, died from the effects of experiments in X-rays. Dr. Simon was a pioneer in the use of the X-ray and has endured many operations and amputations as a result of his investigations.

MR. JOHN A. SWEETSER, formerly president of the Lexington (Mass.) Gas and Electric Light Company, died suddenly of heart failure at South Farmingham, Mass., on December 8. Mr. Sweetser was born in Newburyport and lived in Grafton many years, where he held various public offices, moving to Lexington in 1901. He was 75 years of age.

PROF. ALFRED G. COMPTON, former head of the physical department at the College of the City of New York, who retired in December, 1911, after serving on the Faculty of the college for 58 years, died on December 12 at his home in New York City. He was born in England on February 1, 1835, and came to America with his parents in 1842. He was acting president of the college from December, 1902 to September 1, 1903 Professor Compton was a member of the American Society of Civil Engineers, American Institute of Electrical Engineers and of the City College Club. He left two daughters and a son.

DR. DANIEL M. BARTON, general purchasing agent of the General Electric Company, died recently at his home in Schenectady of heart failure after an illness of only five days. Mr. Barton was born in the little village of Moriah, N. Y., in the year 1843. His youth was spent with his father in Ware, Mass., when at the age of 19 he and his brothers, Henry and Silas A. enlisted in the army. He served through the Civil War in the Tenth Regiment Massachusetts Volunteers, which fought at Gettysburg and Fredericksburg. After his return from the war he became a dry-goods merchant in Meriden, Conn., following which he removed to Lynn, Mass., where he followed the occupation of bookkeeper and news dealer. In 1883 the Thomson-Houston Electric Company was formed, one of the leading spirits being Silas A. Barton, and three years later Mr. Daniel M. Barton became the company's first production manager. In 1893 Mr. Barton became assistant purchasing agent of the General Electric Company and in 1894 he was appointed purchasing agent of the company, with headquarters in Schenectady, the home office of that company. This title was later changed to general purchasing agent, which position Mr. Barton filled at the time of his death. He is survived by his wife, daughter and three grandchildren; also his brother, Silas A. Barton, of Waltham, Mass., and a sister, Vila Barton, of Northampton, Mass. Mr. Barton was a true Christian gentleman, exceptionally devoted to his home and family. Endowed by nature with deep human sympathies, which he extended to all, his kind-hearted impulses and sunny disposition coupled with a stern integrity and a scrupulous sense of justice made him a respected and lovable character. His death will cause a keen sense of personal loss, not only to his business associates, but also to his many friends in the industrial world.

DATES AHEAD.

American Association for the Advancement of Science. Annual meeting, Atlanta, Ga., December 29-January 2, 1914.

Independent Telephone Association of America. First annual convention, Chicago, Ill., January 6-8, 1914.

National Independent Telephone Association. Annual convention, Chicago, Ill., January 13-15, 1914.

South Dakota Independent Telephone Association. Sioux Falls, S. D., January 14-15, 1914.

Wisconsin Electrical Association. Annual convention, Milwaukee, Wis., January 15-16, 1914.

Efficiency Society. Annual convention. New York, N. Y., January 26-27, 1914.

Western Association of Electrical Inspectors. Annual meeting, Cincinnati, O., January 27, 1914.

Northwestern Cedarmen's Association. Annual convention, Escanaba, Mich., January 27-28, 1914.

With the Electrical Manufacturers

Franks Manufacturing Company, Rock Island, Ill., has supplied a large number of its adjustable lighting fixtures in the large building of the United Woodmen of America, which has its headquarters in Rock Island. All typewriter machines, adding machines, etc., have been equipped with Franks fixtures.

Century Electric Car Company. Detroit, Mich., has opened an agency in Boston, Mass., at 410 Newbury Street. Edward Atkins, who is financially interested in the company, is in charge of the New England territory, and it is the intention to establish agencies in the principal cities. The company's output consists of a four passenger, underslung brougham, and a five passenger car having duplex control.

Ideal Case-Hardening Compound Company, 1784 Broadway, New York City, announces that it has appointed McLeod & Miller, of 416 Broadway, Detroit, Mich., as its representatives for the State of Michigan. The company has issued a 38-page booklet entitled "Case-Hardening and Heat-Treating of Steel," which contains much valuable information and will be sent to those interested in the subject.

National X-Ray Reflector Company, 235 West Jackson Boulevard, Chicago, has this month begun the issue of a monthly house organ entitled "Eye Comfort Illumination from Concealed Sources." This will be sent to the electrical and fixture trade every month for the purpose of supplying information on proper methods for the installation of indirect lighting equipment. New lines of indirect fixtures are also described.

Hoskins Manufacturing Company, 453 Lawton Avenue, Detroit, Mich., has issued bulletin No. 8 describing the Hoskins electric furnaces of the type FB. The bulletin has 20 pages with numerous illustrations showing the furnaces and diagrams of their connections as well as many installations in various laboratories and used for a variety of purposes. The construction and operation of these furnaces and their advantages are clearly set forth in detail.

Beardslee Chandelier Manufacturing Company, Chicago, Ill., in its December number of *Beardslee Talks*, the well known monthly publication of this fixture company, calls attention to some special holiday trade bargains, which being in broken lots are offered at one-third reduction from the wholesale price in order to clear out the line. A considerable number of designs of various shower and other ceiling fixtures are also shown. An article gives useful pointers in trailing new fixture business.

Ray D. Lillibridge, Incorporated, New York, announces that the company has no idea whatever of abandoning its present location, nor of making it subordinate to any other. General circulation seems to have been given to a report that Mr. Lillibridge was to give up his business in New York and take up exclusively the exploitation of some California interests. It is true that there is contemplated the opening of an office in San Francisco next year, to take care of the interests of some of the company's clients in anticipation of and through the Panama-Pacific Exposition, but this will not affect the New York office.

Maschinenfabrik Oerlikon, Oerlikon, Switzerland, has issued a large bulletin describing and illustrating the installation of electrically operated traveling cranes in a large iron and steel mill in Rome, Italy. In this establishment there are used a large number of electric cranes ranging up to a capacity of 120 tons. The bulletin contains many fine illustrations of various departments in these works and shows particular views of the cranes, their motors, and control gear. This firm has also issued a bulletin dealing with single-phase repulsion railway motors. These are built in sizes of 25 horsepower and for a maximum speed of 1,300 revolutions per minute at 50 cycles per second.

The Electric Storage Battery Company, Philadelphia, Pa., has issued section SL of its sectional price lists of storage batteries. This particular pamphlet contains 20 pages devoted to the new Exide type X starting battery. This is a newly designed storage battery built to meet the severe requirements of electric self-starting and lighting service for gasoline automobiles. It has an unusually high capacity per unit of weight obtained by giving the element an exceptionally large plate area. This meets the very heavy discharge demands incurred in starting service and also permits rapid charge and overcharge with minimum heating and wear on the plates. The pamphlet is illustrated with many diagrams showing the arrangement of batteries of various voltages and complete data and prices are given.

The Robbins & Myers Company, Springfield, O., has opened a St. Louis branch office in the Chemical Building, under the management of I. Elkas, formerly connected with the St. Louis office of the Sprague Electric Works of the General Electric Company. A. S. Chamberlain has recently assumed the duties of manager of the New York office of the company. A branch office has been opened in Cleveland in the Marshall Building, under the management of A. J. Reed. The Cincinnati branch office of the company is now located at No. 9 East Third Street, under the management of G. H. Liebel. A new catalog has just been issued by the company, designated as bulletin No. 105, illustrating and describing "Standard" type N fractional-horsepower direct-current motors, which are interchangeable with the company's line of "Standard" type P alternating-current motors.

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., reports the following among recent orders. Charlotte Electric Railways Company, Charlotte, N. C., one 750-kilowatt, 600-volt direct-current, six-phase, 60-cycle rotary converter; three 275-kilowatt, single-phase, 2,200-volt transformers; one switchboard for the control of the bove apparatus; one 50-light arc rectifier outfit and panel. Philadelphia Suburban Gas & Electric Company, Philadelphia, Pa., two 100-kilowatt, 60 and 25-cycle frequency-changer sets; two 150-kilowatt, three-phase, 13,200-volt transformers. Connecticut Power Company (through Stone & Webster Engineering Corporation), three 500-kilowatt, 66,000 volts high tension, 2,300 volts low tension, single-phase, 60-cycle self-cooled transformers and twelve 1,000-kilowatt, 66,000-2,300-volt single-phase water-cooled transformers. Duquesne Light Company, Pittsburgh, Pa., two 200-kilowatt induction motor-generator sets.

Harrington & Peebles, 220 South State Street, Chicago, Ill., advisory engineers on boiler-room economy, have consummated a deal of interest to all power-plant owners. This consists in an arrangement with the Illinois Traction System, whereby Messrs. Harrington and Peebles are to establish a school of instruction at the Peoria plant for the benefit of the superintendents, engineers and boiler-room foremen of the Illinois Traction System. Mr. Harrington will start this work immediately after the holidays. His plan is to equip one boiler at this plant with a full set of both indicating and recording instruments to show and record all of the draft and temperature changes that take place in the different methods of firing. Both coal and water will be continuously measured and a test of considerable refinement can be conducted at a moment's notice. It is planned to have diagrams of the boiler on a large scale whereon actual draft instruments are placed, so that the draft changes throughout the entire boiler can be observed at a glance and the effect of damper and fuel-bed changes immediately noted.

General Electric Company, Schenectady, N. Y., reports receiving the following among a multitude of recent orders. Minneapolis & Ontario Power Company, International Falls, Minn., a 2,000-kilowatt. Curtis turbogenerator with 17.5-kilowatt motor-generator exciter set, 5 and 25-horsepower motors, pumps, condenser equipment, etc. California-Oregon Power Company, Yreka, Cal., two 50, one 100 and four 200-kilovolt-ampere transformers. United Electric Light & Water Company, Waterbury, Conn., three 600-kilovolt-ampere trans-

formers and accessories. Chase Rolling Mill Company, Waterbury, Conn., a 750-kilovolt-ampere alternating-current generator. Eastern Metal Corporation, Bayonne, N. J., a 370-kilowatt, two-unit motor-generator set with blower equipment and switchboard. Standard Steel Car Company, New Castle, Pa., 54 motors ranging from 5 to 50 horsepower. Union Iron Works, San Francisco, Cal., four additional 200-horsepower induction motors with starting compensators. United States Aluminum Company, Pittsburgh, Pa., ten 20-horsepower induction motors with starting compensators. D. Auerbach & Sons, New York, N. Y., candy manufacturers, 103 motors ranging from 1 to 30 horsepower with control panels and accessories. American Zinc & Chemical Company, Burgettstown, Pa., two 2,000-kilowatt Curtis turbogenerators with 35-kilowatt turbo-exciters, a 435-kilowatt motor-generator set, a 300-kilowatt generator, switchboard, etc. Lehigh Portland Cement Company, Allentown, Pa., a 1,250-kilovolt-ampere alternating-current generator and switchboard. Firestone Tire & Rubber Company, Akron, O., five large three-phase, 60-cycle, 440-volt motors, comprising one of 400 horsepower, two of 500 and two of 700 horsepower with control panels. Linde Air Products Company, Kansas City, Mo., five motors, ranging from 10 to 100 horsepower, with switchboard panels.

Record of Electrical Patents.

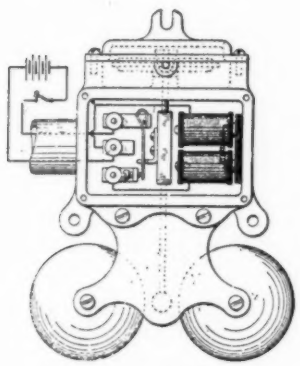
Issued by the United States Patent Office, December 9, 1913.

1,080,535. Circuit-Controller for Electric Signs. F. C. Brodie, Moose Jaw, Sask. A rotary insulating cylinder with centrifugally movable pivoted blades adapted when thrown out to connect adjoining stationary contacts.

1,080,543. Flash-Light Attachment for Cameras. P. Dietz, assignor to New Ideas Mfg. Co., New York, N. Y. Electrical ignition of the flash powder takes place prior to the release of the shutter.

1,080,544. Wireless Signaling System. C. D. Ehret, Ardmore, Pa. A receiver system comprises a condenser detector in the antenna circuit across which is connected a local circuit with a source of alternating current, a telephone and an inductance.

1,080,548. Motor Stand for Adding



1,080,584.—Electric Bell.

Machines. C. E. W. Gardner, assignor to Burroughs Adding Machine Co., Detroit, Mich. Supports the electric motor, machine and controller.

1,080,563. Electric Switch. O. M. Knoblock, South Bend, Ind. Horizontal knife switch.

1,080,583 to 1,080,585. Electrical Apparatus. H. E. Reeve, New York, N. Y. Three different constructions for electric bells. (See cut.)

1,080,587 and 1,080,588. Multiple Control of Electric Motors. R. Richter, assignor to Maffei-Schwartzkopff Werke G. M. B. H., Berlin, Germany. Control for single-phase locomotive units having step-down transformers with potential taps and a rotary motor-voltage regulator.

1,080,589. Vehicle Signal. E. B. Roedding and G. E. Roedding, Detroit, Mich. Includes an electromagnetically controlled electric motor.

1,080,605. Inductance Coil. F. G. Thackaberry, Tampico, Ill. Comprises two parallel coils each with the wire exposed along a longitudinal line on which an adjusting contact can be moved.

1,080,608. Time-Controlled Mechanism for Operating Electric Switches. J. C. Van Slyke, Fort Collins, Colo. A compensating clock mechanism for opening and closing the switch.

1,080,609. Driving Mechanism for Vibrators. J. Vieson, Detroit, Mich. Driven by an electric motor through cone pulleys.

1,080,611. Laminated Core for Electric Generators and Motors. H. H. Wait, assignor to Rateau Battu Smoot Co. Has plates of copper between the iron laminations and projecting beyond the exterior surface of the windings to form flanges to dissipate heat.

1,080,616 and 1,080,617. Hickey. Paul T. Zizinia, New York, N. Y. The first patent provides or having both the wires entering at one side. The second patent covers a hollow hickey with several differently threaded necks for securing to the insulating joint and intervening wireways.

1,080,626. Coin-Operated Mechanism. H. Fachs, New York, N. Y. Has electrically actuated mechanism.

1,080,667. Electric Toaster. A. A. Warner, assignor to Landers, Frary & Clark, New Britian, Conn. Vertical type toaster with sectional heating units.

1,080,681. Wave-Detector. J. H. Cuntz, Hoboken, N. J. In the antenna circuit is a fine stream of mercury kept in continual circulation. (See cut.)

1,080,692. Shiftable Screen for Moving Pictures. F. W. Hochstetter, New York, N. Y., assignor to H. P. Patents & Processes Co. Electrically operated.

1,080,712. Trolley-Wire Clamp or Fastening Device. G. A. Mead and F. S. Denneen, assignors to Ohio Brass Co., Mansfield, O. Has special pivoted clamping jaws.

1,080,713. Strain Insulator. G. A. Mead and W. H. Kempton, assignors to Ohio Brass Co. Has special intermediate shell.

1,080,717. Governor for Centrifugal Air-Compressors. R. H. Rice, assignor to General Electric Co. Float-controlled speed regulator for the driving motor.

1,080,730. Circuit-Controlling Mechanism for Electric-Railway Switches. C. W. Squire, Beverly, Mass. Controlled through a trolley-operated contact.

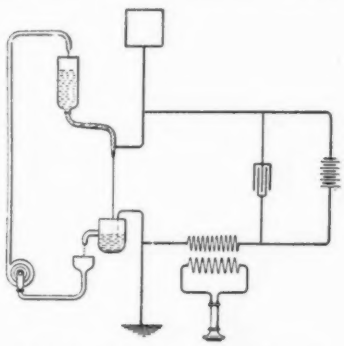
1,080,750. Flash Machine. J. L. Courson, Barberton, O. A number of vessels for receiving flash powder are arranged around the periphery of a revolving plate; each vessel contains an ignition electrode which in turn engages a brush electrode connected to a high-tension source.

1,080,761 and 1,080,762. Hydrocarbon Motor. R. Huff, assignor to Packard Motor Car Co., Detroit, Mich. A special bracket on the engine frame supports the ignition magneto, which is worm-geared to the engine.

1,080,782. Variable-Speed Mechanism for Motor Vehicles. J. C. Riegel, Pottsville, Pa. Has a two-part electromagnet coupling between the differential gearing and the engine shaft.

1,080,788. Timer and Distributing Device. J. M. Smith, Philadelphia, Pa., assignor of one-half to C. A. Magruder. Covers details of construction.

1,080,795. Searchlight Attachment for Shot Guns and the Like. E. S. Ward, Portland, Oreg. Includes dry cells, a lamp, a lens and switch.



1,080,681.—Mercury Wave-Detector.

1,080,807. Art of Manufacturing Steel. G. H. Benjamin, New York, N. Y. Electric refining constitutes one step in the process.

1,080,824. Electrical Reduction-Furnace. R. E. Frickey, assignor to Noble Electric Steel Co., San Francisco, Cal. Four Y-connected three-phase electrodes project into the crucible between five feed stacks.

1,080,826. Heating and Purifying Water. G. H. Gibson, assignor to Harrison Safety Boiler Works, Philadelphia, Pa. Electrolytic purifying process.

1,080,830. Electrical Coil and Method of Winding Same. M. Helm, assignor to J. R. Leeson, Boston, Mass. Consists of layers of helical wire windings and intermingled cross windings of yarn or thread.

1,080,840. Electric Furnace. G. Massip, Levallois-Perret, France. A tilting arc furnace.

1,080,852. Storage Battery. A. H. Snyder and J. Starkenstein, New

York, N. Y., assignors to Gould Storage Battery Co. A rigid bar with handle extends across the top of the jar and has a detachable sling passing from its ends around and beneath the jar to permit lifting it.

1,080,862 to 1,080,866. Electric Zinc-Furnace with Integral Condenser. J. Thomson, New York, N. Y. These five patents cover modifications of a zinc-smelting furnace with a bed of carbon as a reaction resistor supported on a filter bed.

1,080,871. Electric Switch. J. N. Wallace, assignor to Western Electric Co. For a telephone switchboard; has a series of adjoining keys.

1,080,897. Manufacture of Double Helical Metallic Tubing. H. J. Davies and T. A. Judge, Sheffield, England. Produces intermittent electric welds between the inner and outer strips by means of a pair of rotating electrodes.

1,080,904. Electric Lamp-Holder and Reflector. L. M. Fluhart, Des Plaines, Ill. Combined socket and reflector base.

1,080,908. Thermoelectric Switch. H. Gillette, Chicago, Ill. A thermostatic make-and-break device.

1,080,912. Method of Electrically Smelting Volatile Metals. W. McA. Johnson, Hartford, Conn. Electric zinc-smelting furnace and condenser.

1,080,947. Casing for Resistances. A. W. Berresford, assignor to Cutler-Hammer Mfg. Co., Milwaukee, Wis. An inclosing casing for a starting box has a reflex ventilating flue. (See cut.)

1,080,988. Bean-Assorter. R. F. McWilliams, Barryton, Mich. Comprises an endless belt, an electromagnetically adjusted chute and an electric control circuit with selenium cell, for sorting the beans by their light-reflecting power.

1,081,021. Advertising Device. J. F. Cunningham, San Francisco, Cal. A clock with electric lamps and reflectors.

1,081,022. Electrical Switch. O. L. Davis, Iowa City, Iowa. Has multiple push-buttons with a rocker shaft, ratchets, contact disks and arms.

1,081,034. Chair for Theaters or the Like. A. Forster and H. Wanek, Vienna, Austria-Hungary. An incandescent electric lamp in the chair frame lights up when the seat and back are swung to unoccupied position.

1,081,052. Electrically Operated Alarm Clock. W. P. Locke, Chicago, Ill., assignor of one-third each to J. A. Kress and F. A. McGowan. An electrically wound clock with electric alarm.

1,081,072. Guard for Springs. S. P. Wilbur, assignor to Nernst Lamp Co., Pittsburgh, Pa. A guard for spring glower support for Nernst lamp.

1,081,084. Dynamo-Electric Machine. V. G. Apple, assignor to Apple Electric Co., Dayton, O. Inclosed ignition generator with framework extended about the commutator so as to hold the brushes.

1,081,090. Electric Conversion. S. Cabot, Brookline, Mass. Means for obtaining a direct current from oscillation circuits periodically connected.

1,081,114. Apparatus for Heating Liquids by Electricity. J. van Hentzel, Zurich, Switzerland. For attaching to a water hydrant.

1,081,119. Switch. A. W. Johnson, Holland, Mich. Depression of a button moves a block to circuit-closing position and springs normally hold the block in circuit-opening position.

1,081,128. Switching Mechanism for Telephone Exchanges. F. A. Lundquist, assignor to Western Electric Co. A circuit-finding contact-maker moves step by step through relays.

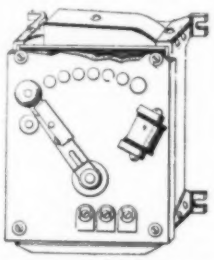
1,081,160. Multiple-Fuse Device. G. S. Shoupe and W. H. Palmer, Cleveland, O. Sliding contacts permit several fuses to be put into circuit one after another.

1,081,164. Smelting or Refining of Metals and the Like in Crucibles. H. G. Solomon, London, England. An induction furnace with transformer, the secondary of which is formed by an annular crucible.

1,081,191. Process for the Electrolytic Manufacture of Perborates. K. Arndt, assignor to Chemische Fabrik Grünau Landshoff und Meyer Aktiengesellschaft, Grünau, Germany. Consists in electrolyzing a solution of a mixture of sodium carbonate and borax.

1,081,213 and 1,081,214. Inclosed Electric Fuse. F. N. Conant, assignor to Chase-Shawmut Co., Boston, Mass. Provided with a spring indicator.

1,081,224. Fire-Fighting Apparatus. A. C. Farrand, Atlantic City, N. J., assignor of one-half to F. C. Stover. An automobile with gasoline engine,



1,080,947.—Ventilated Starting Box.

dynamo directly driven thereby, motor driven by the dynamo, centrifugal pump and propelling gear.

1,081,233. Electric Heating Element. D. Huntley, London, England. Electric radiator stove.

1,081,244. Electric Fan. G. C. Marx and A. F. Becker, assignors to Diehl Mfg. Co., Elizabeth, N. J. Worm-gear oscillating mechanism for desk and bracket fans.

1,081,260. Device for Electromagnetic Suspension. H. Zoelly, Zurich, Switzerland. Includes an adjustable load-bearing magnet adapted to free lateral movements.

1,081,266. Resetting-Circuit for Annunciators. J. O. Cadieux, assignor to Connecticut Telephone & Electric Co., Meriden, Conn. Attraction of an indicating armature to its call magnet closes a break in the resetting circuit to prepare it for operation.

1,081,277. Battery Electrode. J. J. Auringer, Cohoes, N. Y. Is formed of gas carbon and has an exposed surface of flake retort carbon bonded thereto.

1,081,278. Electric Burglar-Alarm. H. S. Bitting, Lancaster, Pa. Includes a normally closed property circuit and two normally open alarm circuits one with bell and the other with lamp.

Patents That Have Expired.

Following is a list of electrical patents (issued by the United States Patent Office) that expired December 15, 1913.

572,945. Mechanical Telegraph Sounder. W. W. Alexander, Kansas City, Mo., and M. C. Gillham, Kansas City, Kan.

573,009. Direct-Current Dynamo-Electric Generator. B. G. Lamme, Pittsburgh, Pa.

573,021. Electric Meter. W. D. Marks, Philadelphia, Pa.

573,033. Electric Railway System. B. E. Osborn, Auburn, N. Y.

573,041. Electric Furnace. M. Schindler, Neuhausen, Switzerland.

573,042. Electric Boiling Apparatus. F. W. Schindler-Jenny, Kennelbach, Austria-Hungary.

573,066. Electric-Railway Construction. G. Westinghouse, Pittsburgh, Pa.

573,078. Wattmeter. T. Duncan, Fort Wayne, Ind.

573,079. Meter for Measuring Electric Currents. T. Duncan.

573,080. Electric Meter. T. Duncan.

573,082. Electric Meter. C. Erben, Berlin, Germany.

573,088. Electric Sign. F. H. Hawkins, New York, N. Y.

573,092. Insulator. F. M. Locke, Victor, N. Y.

573,101. Wall Insulator. J. J. O'Neill, Boston, Mass.

573,105. Collecting Brush. E. B. Raymond, Schenectady, N. Y.

573,107. Securing Field-Magnet Poles. H. G. Reist, Schenectady, N. Y.

573,117. Telephone-Circuit Line-Signal. T. C. Wales, Jr., and C. H. Arnold, Boston, Mass.

573,130. Attaching Field-Magnet Poles. F. O. Blackwell, Schenectady, N. Y.

573,146. Switch. E. M. Hewlett, Schenectady, N. Y.

573,161 and 573,162. Electric Arc Lamp. C. Richter and R. T. Eschler, Camden, N. J.

573,169. Electric Railway. A. Sprague, San Leandro, Cal.

573,176. Electric Cable. F. Borel, Cortaillod, Switzerland.

573,221. Electric Signaling Apparatus. F. B. Herzog and S. S. Wheeler, New York, N. Y.

573,222. Automatic Grounding Device for Electric Conductors. G. A. Jewett, Chicago, Ill.

573,234. Electric Railway. A. C. O'Connor, Lynn, Mass.

573,245. Electric Soldering Club. P. Stotz, Stuttgart, Germany, and F. W. Schindler-Jenny, Kennelbach, Austria-Hungary.

573,257. Trolley-Pole Safety Device. B. H. Borreson, Minneapolis, Minn.

573,283. Headlight for Electric Cars. J. H. Neal, Boston, Mass.

573,286. Receiver for Submarine Telegraphs. A. Piedmont, Paris, France.

573,294. Telephone Transmitter. F. A. Ray, Boston, Mass.

573,302. Conductor of Electricity and Conduit for Holding Same. A. Selkirk, Albany, N. Y.

573,344. Switch for Electric Railways. S. A. Mustein, Rincon, N. M.

573,356. Telephone Transmitter. L. W. Pullen, Camden, N. J.

573,387. Combination Gas and Electric Fixture. J. E. Brown and W. M. Brown, Toledo, O.

573,398. Electric Arc Lamp. A. C. Dobrick, Chicago, Ill.

573,430. Self-Winding Mechanism for Electric Clocks. C. M. Crook, Elgin, Ill.